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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Registered Office and Laboratories of the B.C.I.R.A. at:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. *Telegrams: CIRA*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone* 332)

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Mechanisation

Last week we devoted a day to visiting one of the largest British mechanised foundries, and because of its apparent rather than real complication, we began to examine the fundamental principles of the subject. There can be at least two *modus operandi*, the first of which would endeavour to create common circuits for liquid metal, sand, cores and finished castings. This involves making all the various means of conveying heavy enough to deal with the largest casting made in the circuit. It involves a hotchpotch tackle for pouring, drying, at the knockout and along the cleaning line. If the foundry be of considerable dimensions, it demands outsize sand-preparing units and much cost for standby machinery. It assumes that a standard grade of sand can be prepared equally suitable for backing and facing sand and for large and small castings. We do not believe that the science and art of foundry practice or mechanical efficiency has reached such a point that such conditions can be supported by actuarial proof.

The second system is one of segregation of the plant into units designed to take care of a *line* of castings, with modifications designed to suit liquid metal supply, sand requirements, knockout handling, possible segregation for cooling and cleaning.

For the largest foundries this may involve three to six moulding circuits, but for foundries of more modest pretensions, the objects of a mechanised foundry would seem to be best served by taking the type of casting for which there is the best and most consistent demand, adding to it only those castings which will easily fit into the general scheme. For the rest, there must be a profound study made of mechanised conditions to aid the general production of the shop. A monorail extension may simplify or complicate pouring conditions, whilst the use of intermittently-operated conveyors could be made to supply the jobbing floor, and certainly outsize or one-off jobs could be knocked out at a place feeding the system sand supply. Furthermore, there is good reason for believing that one conveyor, if reversible, can be used for more than one job. We can imagine a reversible conveyor used for bringing in new sand right over the jobbing floor, which when used in the opposite direction could supply, by ploughing off into hoppers, system sand for use on that floor. Undoubtedly much can be done by the intelligent application of mechanisation, but where a large variety of jobs are made, it is sound advice to make a start at the earliest opportunity and gradually to extend the scope to embrace as much of the production as possible. For instance, in a shipbuilding foundry it should be possible to establish a modern central sand-preparing plant, to convey it either by conveyor or crane to fill hoppers above moulding stations and to knock out, except for pit work, at one definite place.

The Mersey Tunnel

The Mersey tunnel, opened so recently by H.M. the King, embodies sufficient cast iron in its construction to warrant more than a passing record, for it is the largest subaqueous tunnel in the world and one of the most remarkable engineering achievements of an age very rich in them. Four lines of traffic are accommodated in a tunnel over two miles long. The roadway above was supported during construction by a semi-circular shield weighing over 200 tons and nearly 47 ft. in diameter. The cast-iron tunnel segments were virtually laid on the inside of the skin of the shield. The segments themselves weighed nearly a ton each, and were put in place by specially-designed mechanical erectors. The segments weighed in all some 82,000 tons, and reached in number nearly 112,000. The straight segments were 6 ft. long and about 2 ft. wide. We understand that 1,250 tons of segments were made per week on day and night shifts, two castings per box being produced each 24 hrs. It is interesting to note that after exhaustive tests a cast-iron road was laid for the traffic, the setts having specially-hardened diamond-shaped studs to prevent skidding. Ventilation and illumination presented special problems. The total cost of the scheme amounts to eight million sterling, of which two and a half millions are being contributed by the Government.

Altogether founders have reason to be proud of the part played by cast iron in this great undertaking, which demonstrates in a very clear way Lancashire's faith in itself during a very trying period. Finally, we think that those who first originated the idea, those who designed and those who made it could scarcely have had paid to them a more perfect tribute than that of H.M. the King, at the opening ceremony. Referring to the tunnel carrying wheeled traffic below tidal water carrying the ships of the world, he added, "I praise the imaginations that foresaw, the minds that planned, the skill that fashioned, the will that drove, and the strong arms that endured in the bringing of this work to completion." Those words were spoken for all of us, and to them nothing can be added.

C

Industrial Laboratory Extension

As the firm of Ridsdale & Company is well known to most of our readers, it is a matter of interest that they have seen fit to enlarge their premises recently. Their metallurgical and consulting practice was established at Middlesbrough in 1911 by Mr. C. H. Ridsdale, F.I.C., F.C.S., etc., and his son, Mr. N. D. Ridsdale, F.C.S.

FIG. 1.—CORNER OF NEW LABORATORY EXTENSION AND BALANCE ROOM, MESSRS. RIDSDALE & COMPANY.

The ideal of this company has been to raise the standard of analytical chemistry, mainly in the metallurgical field. With this object, Mr. C. H. Ridsdale began by inventing the "Analoid System of Analysis" in 1906, a system which involves the standardisation and simplification of methods of analysis, and includes the redesigning of them so as to eliminate many operations, such as filtration and neutralisation. In addition, the process diminishes the number of solutions which need to be prepared.

In 1916 Messrs. Ridsdale & Company started another line of approach to the achievement of accuracy in analysis, by preparing, with the assistance of a number of other chemists of experience, representing many different interests, a series of standard analysed samples termed British Chemical Standards. These are too well known to need any description here, since they are used in well over 1,000 laboratories in Great Britain and abroad.

About ten years ago the firm became more intimately associated with foundry work, and Mr. N. D. Ridsdale's interest in moulding-sand testing led him to read a Paper on the subject, for which he was awarded the I.B.F. Diploma a few years ago. The substantial development of the Analoid System of Analysis, the British Chemical Standard Movement, and the subject of moulding-sand testing have been the chief causes which made it imperative for Messrs. Ridsdale & Company to provide themselves with better accommodation by taking over the adjoining premises.

FIG. 2.—MOULDING-SAND-TESTING LABORATORY, MESSRS. RIDSDALE & COMPANY.

The analytical laboratory has been extended so as to provide better facilities for non-ferrous analysis, including electrolytic determinations, and some of the more complex alloys now being analytically standardised. Fig. 1 shows a corner of the new laboratory extension and balance room. The storage of standard bars, together with about 10 years' supply of special turnings and the packing of the finished standards under conditions of extreme cleanliness and care, has demanded increased space and convenience.

A special department on the ground floor (Fig. 2) has been devoted to testing and the experimental milling of sands. Owing to the dusty and gritty nature of such sands, this work is kept quite separate from the other laboratory work. A room has been set aside as a library so that ready reference to technical literature may be had by the staff. With these increased facilities Messrs. Ridsdale & Company will be more fully equipped to undertake their wide variety of work and to keep abreast of the times.

Mr. W. H. Whittle

CHAIRMAN, INSTITUTE OF VITREOUS ENAMELLERS

It is largely to the enthusiasm displayed by Mr. Wm. H. Whittle that the Institute of Vitreous Enamellers has been so successfully inaugurated. Mr. Whittle is a director and commercial manager of the Protector Lamp & Lighting Company, Limited, of Eccles, near Manchester. He received his early training at Uttoxeter and carried out his specialised training at the Manchester School of Technology. He served his apprenticeship with his present firm and has now 35 years' experience in the vitreous-enamelling industry, principally in connection with the sheet-iron section, manufacturing signs, notice plates, cooker linings and the like. He is a member of the British Standards Institute Committees and a member, and former chairman, of the Miners' Flame Lamp Research Association, in which field he holds numerous Patents for lamps and fittings. In his spare moments he interests himself in sport—he is President—after being captain of the Montan Cricket Club, whilst horticulture and agriculture also claim his interest, and he is a member of various committees and societies interested in these activities.

MR. W. H. WHITTLE
(Chairman, Institute of Vitreous Enamellers).

Carbon Control for Cupola Melting

By J. L. Francis

Advantages of Cupola Furnaces

Many kinds of furnace are available to-day for reducing pig and cast iron to the molten state and imparting sufficient superheat to render the metal suitable for pouring into moulds. Of these, some are of recent development, for which better control of melting conditions than can be had with the cupola is claimed. Indeed, it is customary to compare them all with cupola melting, and each one is said to possess at least one outstanding advantage over the older melting unit. Some represent a real step forward, and are indeed a notable advance. Others, one gradually hears of less and less. However, for economy of operation, general convenience, adaptability to greatly varying conditions, elasticity over a wide range of requirements, continuous melting, and for working sometimes under the most adverse methods of operation, a melting unit to replace the cupola has yet to be invented.

Amongst the claims of the later-type furnaces, control of the total-carbon content has always a prominent position. Much work in this direction has also been applied to cupola-melting practice. If full advantage is taken of knowledge now available, a considerable degree of carbon control is capable of being exercised. Personal opinion is that the possibilities latent in this fact are not usually taken into sufficient account when comparison of cupolas with other-type furnaces is being made. Thus, in these days, when economic conditions enforce that the maximum of results be obtained with a minimum of expenditure, it may not be inopportune to emphasise and review methods for carbon control, and hence production of higher-quality cast iron from the cupola installations already existing in the majority of foundries.

Carbon Content and Sound Castings

Production of the latest type of special-duty alloyed cast irons often calls for the use of pig-irons of low total-carbon content initially. Naturally, being of the refined type, these are expensive. On melting with other charge components in the cupola, if the carbon pick-up is great, their benefit is to a large extent nullified, and the extra expense goes for nothing. On the other hand, control of the carbon does not always involve the obtaining of this element in the smallest amount possible in the casting. This limited application of control is not desirable in every case. When total-carbon content falls much below 3.0 per cent., founding difficulties are greatly increased. By making use of the latest developments in cupola melting to controlling the carbon content, its ratio in the final product can be fixed, within small limits, to any predetermined amount. F. Hudson[1] has established that for castings, such as cylinders, having variation of section thickness, a percentage of 3.5 total carbon yields the soundest product. An increase in total-carbon content causes liquid expansion for a given cooling rate and casting section, an important factor for imparting solidity to the freezing metal. The effect of the high carbon content towards increase in size and quantity of graphite may be satisfactorily counteracted by use of low phosphorus content, imparting toughness.

Effect of the Quality of the Coke Used

Coke is an important item in all cupola charges, so that its effect on carbon control may well be considered first. In this respect, the reactivity value is of no little consequence. The reactivity value is measured by the extent to which the coke is capable of reducing CO_2 to CO. Reactivity rises with increase in temperature, and, although the problem of what properties are best suited to a coke for use as fuel in a cupola is not a simple one, most indications point to the desirability of having a low reactivity value. Hard, large-sized coke of dense structure fulfils this requirement. Such coke holds up well in the bed and is slow burning. It is very noticeable that soft, friable cokes give a greater carbon pick-up, apart from causing much trouble in other ways. From this one may conclude, as J. Mackenzie[2] has demonstrated, the structure of the coke is of fundamental importance, and may counteract to a considerable extent the effect of the chemical composition. Beehive cokes give lower reactivity values than do by-product cokes, and, maybe, this is partly the reason why they have preference over the by-product coke amongst some foundrymen. A further development of low reactivity value, coupled with less carbon pick-up, is the work done by F. W. Corsalli. He has put forward a method whereby the coke lumps are rendered less reactive by a coating of lime. The lime-coating process is modified according to the quality of the coke and the purpose in view. Indeed, it has been found possible so to protect the coke by this means that it will not burn at all.

Effect of the Quantity of Coke Used

There is no doubt at all that varying the quantity of coke used for melting the cupola charges exerts a corresponding influence on the carbon pick-up, and thus on the ultimate total-carbon content. It was in 1925 that the author first noticed this effect, and made experiments to prove it conclusively. At the time it was part of the melting practice to run two grades of iron. Due to the conditions of working, it was necessary to have charges of both grades in the cupola at the same time. The usual method of increasing the coke split as a means whereby the separation could more easily be effected was adopted. No matter which grade was charged first, that following after the extra coke addition was invariably found to have a higher total-carbon content. After the study of a large number of chemical analyses, and making due allowance for other variables, it was decided that the additional coke charged had the effect of bringing up the total-carbon figure by an amount varying between 0.2 and 0.4 per cent. Under the general standard method of working the cupola, the normal coke to iron melted ratio came to be 1 to 7. The quantity of coke used extra for the purpose of separating the charges brought this ratio up to 1 to 6 for the charge directly following.

The above experience amply demonstrates the point, since emphasised by many other investigators, that the regulation of the charge coke is an important factor in the control of the carbon pick-up. So also is the weight or quantity of coke charged for the bed. Where it is the desire to obtain low total-carbon contents, furnaces fitted with receivers are an advantage. Less bed coke is needed, as the tuyeres can be placed much nearer to the cupola bottom.

Effect of Melting Speed

Iron is usually required to leave the cupola at as high a temperature as possible. The hotter the iron the greater is its power for absorbing carbon as a result of increasing its saturation point. In the melting zone there is a mass of carbon at incandescent heat. The iron passes through this in the form of small drops. Conditions are, therefore, ideal for interaction of the carbon and the iron. Thus it is a question of the time for which the iron is on contact with the white-hot coke, whether it can pick up sufficient carbon to become saturated or reach equilibrium conditions at the prevailing temperature. Where the period of time taken for passage through the melting zone is small, the less is the likelihood of equilibrium conditions being obtained, and therefore the less the carbon pick-up. However, carbon pick-up is by no means discontinued after passage through the zone of maximum temperature if the molten iron is allowed to remain in contact with the bed coke in the cupola well. Temperature, time of contact, and concentration are basic laws of solution, so that carbon will continue to be taken up unless the iron is removed from contact with it, as is the case where receivers are fitted. Hence it follows that for any given temperature of melting, the greater the speed of melting and removal of the molten iron from contact with incandescent coke, the less is the carbon pick-up likely to be.

Effect of Blast

The atmosphere of combustion in the cupola has a most important bearing on the carbon pick-up during melting. This is directly controlled by the volume and pressure of the blast. Much has been printed concerning the profound influence which correct air volume plays in the success or otherwise of cupola operation. Notwithstanding it is very doubtful if even to-day the question is given the serious consideration which it merits. For proper attempt at blast control, a blast pressure and volume gauge are necessary together with valves to the tuyeres. Judging by the absence of any such fitments on the majority of cupolas, proper scientific running of these furnaces is still the exception rather than the rule. It is a great mistake that this should be so, as a cupola is just as amenable to proper running as is, for example, a steam boiler. No engineer of to-day would think of operating his plant under the uneconomic conditions of coal consumption of, say, 50 or more years ago. Yet many cupolas are still worked under just such ignorance or neglect of modern practice.

A long time has passed since F. J. Cook claimed that he could obtain hard or soft iron at will by blast adjustment, and, although this may not be the best way of obtaining the variation, he was to a large extent correct. Briefly stated, excess of air put into the cupola at comparatively high pressure will effect decrease in carbon pick-up. Under these conditions the atmosphere in the melting zone is oxidising and a greater loss of silicon and manganese will also take place.

In further stressing the importance of blast control one cannot do better than mention the two greatest steps forward in cupola design made in recent years, and both making control of the entering air their main characteristics. These are the Pomnay and balanced-blast cupolas. Details of their design and operation have been ably dealt with by other writers.[3, 4]. Here it is of interest to note that they each achieve their claims by methods of air supply exactly opposite. Pomnay employs blast pressures higher than normal, whilst Fletcher in his balanced-blast cupolas aims at as low a pressure as possible. Both designs include less carbon pick-up in their list of advantages, and both get it. This is undoubtedly due to the fact that in each type of furnace conditions are so arranged that the coke used in melting is reduced to the minimum amount possible.

Effect of Steel Scrap

Although consideration of the effect of steel scrap on carbon control has been left to this stage, it was actually one of the first efforts made with this aim in view. Great diversity of opinion has been expressed on the subject and much evidence of a conflicting nature put forward. To-day the position is much clearer, and large quantities of steel scrap are melted in cupolas from amounts representing only a small

fraction of the total charge up to 100 per cent. of it, the necessary final analysis being obtained by ferro-alloys and inoculation of the melt.

Reduction of the carbon, by the use of steel in the mixture, to the theoretical figure calculated by striking the mean of the carbon contents of the charge components, is never attained in practice unless molten steel be added to the molten iron or some equivalent procedure adopted. This method is not practicable in the majority of cases, so whilst being ideal practice is not further considered here. Great disappointment has been caused in some cases where use of steel scrap has not reduced the carbon content to the figure expected. The action of the steel in effecting the reduction is as a diluent only. Controversy has waged around the question whether temperatures as developed in the cupola are sufficiently high to melt steel as such. There is no doubt that temperatures of this order are reached in efficient cupola melting. On the other hand it is usually certain that even if the steel remains as steel until molten, it ceases by carbon absorption from the coke to remain so for long after. It is this fact that prevents theoretical carbon reduction from being obtained. The molten steel strives to absorb carbon to reach equilibrium conditions at the existing temperature and would do so if given sufficient time in contact with the carbon. Thus, again, speed of melting and removal from the influence of the incandescent coke is indicated.

From the foregoing remarks the truth brought out by Mackenzie[5] is reflected, namely, that all materials have a tendency to come to the same total-carbon content on repeated remelting, this point being dependent on the coke and the blast. Actually, then the action of steel scrap on the carbon content may be somewhat complicated. Reductions of carbon are possible by its use when certain conditions obtain, under other conditions no reduction at all or even an increase may be registered.

Effect of Chemical Composition

Here again the consideration is one of complication. Some arrangements of the elements present tend to neutralise their separate effects on the amount of carbon content, whilst other arrangements may serve to exaggerate their influences by working together in the same direction. High silicon and high phosphorus lower the absorbing power of iron for carbon. The converse may also be taken as true. As is well known, hematites bear greater total-carbon contents than almost any other type of pig-iron. High-manganese content increases the capacity of iron to take carbon up into solution. Where effects due to manganese content are being dealt with, sight must not be lost of the fact that it is only the content of manganese left over after satisfying the sulphur balance that is available. With regard to the influence of other elements now being used in cast-iron mixtures, a detailed consideration of each is not within the scope of these notes. Generally speaking, their effect on carbon content may be judged by whether they exert a greater or less affinity for carbon than the element which they displace.

REFERENCES.

1 F. Hudson: THE FOUNDRY, August 1, 1929, p. 643.
2 J. Mackenzie: The FOUNDRY TRADE JOURNAL, July 7, 1927, p. 15.
3 J. Cameron: The FOUNDRY TRADE JOURNAL, March 21, 1929, p. 215.
4 H. H. Shepherd, The FOUNDRY TRADE JOURNAL, December, 29, 1932, p. 399.
5 J. Mackenzie, *loc. cit.*

Dorman, Long & Company

It is announced that the resolutions in favour of an extension of the existing scheme of arrangement were carried by the requisite majorities at meetings held on July 12 in London of the 4 per cent. first mortgage perpetual debenture stockholders and of the 5½ per cent. first mortgage redeemable debenture stockholders of Messrs. Dorman, Long & Company, Limited.

Nitrogen Hardening Ni-Cr-Mo Steel

AIR MINISTRY SPECIFICATION

The Air Ministry has issued Specification D.T.D. 228 (H.M. Stationery Office, price 1s.) relating to a 55-65-ton nickel-chromium-molybdenum steel (suitable for nitrogen hardening). This specification is one of a series issued by the Air Ministry either to meet a limited requirement not covered by any existing British Standard Specification or to serve as a basis for inspection of materials, the properties and uses of which are not sufficiently developed to warrant submission to the British Standards Institution for standardisation.

Attention is drawn to the undesirability of using heat-treated bars of large diameter for the production of machined parts, owing to the difficulty of obtaining the specified mechanical properties, particularly the Izod value from such bars. The specification contains the following sections:—(I) Provisions applicable to all sections of this specification; (II) bars and billets for forging; (III) bars for machining (not exceeding 2½ in.); (IV) forgings (other than for crankshafts and airscrew shafts); (V) forgings for crankshafts and airscrew shafts, and (VI) nitrogen-hardened parts.

Chemical Composition.—The chemical composition of the steel shall be (per cent.):—Carbon, not less than 0.25 nor more than 0.35; silicon, 0.35 max.; manganese, 1.00 max.; sulphur, 0.05 max.; phosphorus, 0.05 max.; nickel, 1.00 max.; chromium, between 0.50 and 1.50; molybdenum, between 0.90 and 1.5 The following elements may be present at the option of the steelmaker:—Vanadium, 0.25 per cent. (max.); tungsten, 1.00 per cent. (max.).

Mechanical Tests.—The mechanical properties of the material shall be as follow:—Max. stress, between 55 and 65 tons per sq. in.; elongation, 18 per cent. (min.); Izod, 35 ft.-lbs. (min.); Brinell-hardness number, between 248 and 293; nicked fracture (see below). When the dimensions of a test sample are such that one of the British Standard notched-bar test-pieces cannot be made from it, the nicked-fracture test shall be substituted for the Izod test.

Nicked-Fracture Test.—(i) A test-piece or bar, nicked or sawn so that the area of the portion to be fractured is not less than one-half of the original sectional area, must be free from defects when broken by a minimum number of blows. (ii) For bars over 2 in. dia. or width across flats, the area of the portion to be fractured shall be approximately equivalent to 1½ in. sq., and shall include the core.

Up-ending Test.—From each parcel the Inspector shall select one bar or billet for the up-ending test. From the bar or billet so selected, a sample shall be cut equal in length to its diameter or width across flats and forged down at normal forging temperature to half its original length by a minimum number of blows.

Sulphur-Printing Test.—The Inspector may select one end of one bar or billet for sulphur printing. The resulting prints must not reveal the presence of defects or harmful segregations.

Heat-Treatment.—Forgings shall be hardened by heating to a temperature of 875 deg. C. and quenching in oil. They shall then be tempered by heating to a suitable temperature of not less than 600 deg. C. and quenching in water or oil, or cooling in air, at the option of the manufacturer, to give the tests specified. No forgings shall be re-hardened more than twice.

Nitrogen Hardened Parts

Stabilising Heat-Treatment.—After rough machining, parts may be given a stabilising treatment by heating to a temperature not less than 475 deg. C., nor more than 550 deg. C.

Nitrogen Treatment.—The parts shall be nitrogen hardened by an approved process.

Mechanical Tests.—Further test samples, in addition to the foregoing mechanical tests called for, shall be provided and shall be hardened and tempered, stabilised (if the parts are submitted to this treatment) and nitrogen hardened with each parcel of parts made from the same cast. The test samples may be protected against the absorption of nitrogen, or if not protected, the hardened skin may be ground off the test samples before machining the test-pieces. The hardness number of the hardened case of each finished nitrogen-hardened part shall be to the satisfaction of the Inspector. The hardness number shall be recorded for information purposes.

British Standards Institution

ANNUAL MEETING

At the annual meeting of the British Standards Institution, held on Friday, July 13, Dr. E. Frankland Armstrong, F.R.S., was elected to succeed Mr. E. J. Elford as chairman of the General Council. The report of the work carried out by the Institution during the past year shows all round progress and a considerable expansion. It must be remembered that the B.S.I. now deals with practically any industrial standardisation that the various branches of industry call upon it to undertake.

In the international field, the B.S.I. is closely co-operating with the work of the International Electrotechnical Commission in regard to the problem of interference with broadcast reception due to the operation of electrical apparatus. A meeting was recently held in Paris at which some twelve international organisations were represented, under the ægis of the I.E.C., and such good progress was made, states the annual Report, that it is hoped definite recommendations will be forthcoming at the next meeting, which is to be held in Berlin in the early autumn.

Regarding colliery requisites, a revision has been issued during the year of the steel arch specification which consists primarily of an extension of the original specification to include splay-legged arches as well as the straight-sided and horseshoe types. Provision has now been made for the use of two distinct types of steel, and a full specification is given for each. Other colliery items dealt with include underground lighting fittings, cable glands and sealing boxes, miners' handlamp bulbs, and trailing cables.

Referring to iron and steel, the Report states that the co-ordinating Committee are continuing their detailed study of the British Standard steel specifications, with a view of seeing to what extent it is possible to introduce some measure of rationalisation or simplification. A suggestion has been made that a limited list of specifications for carbon steels should be put forward which would fit in with manufacturing conditions in the steel works and cover various grades of steel required for ordinary engineering purposes, in steps of something in the nature of, say, 5 tons ultimate tensile strength. Such a list of steels, it is thought, would be of considerable benefit to the steel users as a whole, particularly from the design standpoint.

THE FINNISH GOVERNMENT has granted a concession to the Mond Nickel Company for the exploitation of the Petsamo nickel deposits. According to a report from Helsingfors, the British company is entitled to carry on operations in an area 28 miles in length and 1¾ miles broad and to export and sell all the products obtained. Preliminary operations, which must start before May, 1935, will last three years, with an extension of another two years for research, if necessary. The concession is for 40 years, to take effect from the expiration of this three (or five) years period. A royalty of 5 per cent., calculated on the current price of nickel, is to be paid to the Finnish Government. It is expected that the British company will spend about £100,000 during the first three years on research.

Oven Drying of Cores and Moulds

BRITISH AND DOMINIONS CONDITIONS DIFFERENTIATED

Mr. E. G. Fiegehen's Paper* on the above subject, being the first ever accepted from the Dominions for presentation at an annual conference of the Institute of British Foundrymen, was particularly well received. It served a very useful purpose in disclosing differences of thought between domestic and overseas practice in core and mould drying.

Humidity Driers

The discussion was opened by DR. J. G. A. SKERL (B.C.I.R.A.), who, after commenting on the dearth of Papers on the equipment necessary for the efficient drying of cores and moulds and that knowledge of the processes entailed was mainly empirical, said the ovens described in the Paper were known as humidity driers. These driers had been developed mainly for the elimination of moisture, in ceramic ware, such as porcelain, and also for fireclay and other refractory goods where the closeness of the material and the high percentage of water rendered it imperative that drying should proceed evenly and slowly throughout the whole mass of the article if crazing and cracking were to be avoided on the surface. Whether these humidity types of driers and stoves would be as advantageous for moulding-sand practice was a matter upon which more information would be desirable. In a core or mould openness was almost essential in order to get rid of gases formed during casting, and there was also a certain amount of elasticity or give in the sand due to the fact that it was never in practice rammed to the fullest extent, so that there was every opportunity for the water vapour to leave the core without straining it to give cracking troubles. When a mould or core does crack the fault can readily be traced and cured by reference to the amount of bonding material present, the moisture content of the damp sand and the general composition of the mixture without consideration of the stoves or detriment to the castings produced. It would appear that from the cracking standpoint the humidity drier would only be of advantage for moulds and cores in which there were rapid changes of section where the drying strains would be greater than usually encountered.

Synthetic Sand Practice

The sand conditions described in the Paper were almost entirely American and Canadian, in the mixtures of silica sand, clay and the farinaceous or oil type of binder, a mixture which he (Dr. Skerl) had not heard of being used in this country. It would have been of greater interest to British foundrymen if the Paper had been partly sub-divided to deal in one section with the natural sand or even silica sand and clay type of core and mould, and in the other section with oil-sand core practice. In the case of an oil-sand mould or core mixture in which no natural sand was used the necessity of attaining a temperature at which the water could be driven off without cracking the core or mould was not so evident, although it must be remembered that many core compounds contain water.

The Paper would have been enhanced if a time schedule of a humidity drier working on a stated load of moulds or cores had been given, so that a comparison could readily be made with what might be considered normal stove practice in this country. Fireclay and other ceramic ware was dried much more efficiently and quickly in humidity driers, particularly if they are of the tunnel type, than under ordinary stove conditions where the temperature and the circulation of the air is controlled without reference to the humidity. Time, temperature and humidity curves of a humidity drier at work on foundry moulds and cores would be of great interest.

In conclusion, Dr. Skerl stated that the Paper abounded in suggestions as to methods of adequately studying core-oven practice, methods which could be applied to the normal stove practice as carried out in this country.

Two Distinct Problems

MR. W. H. SMITH supported Dr. Skerl's suggestion that it would have been useful to have had a clear dividing line drawn between water-bonded cores and oil-sand cores, for the reason that water-bonded cores would commence to dry at a temperature slightly above 200 deg. Fah. (93 deg. C.), a temperature which had practically no influence on oil-sand cores; a temperature of approximately 350 deg. Fah. (175 deg. C.) must be attained before oil-sand cores began to dry.

One of the essentials, which the author had not made clear, was the type of fuel used. Apparently he was using gas or oil, but the Paper seemed to suggest that gas was predominant. A certain amount of core drying was done by the use of gas in this country, but in the interests of economy most of the core and mould drying was done by coke fuel, which was a much more economical proposition. When using gas, there was not the slightest difficulty in maintaining an even temperature, even without re-circulation; he knew of gas stoves which had been built, not for core drying, but for the second heat-treatment of aluminium alloys, where the temperature did not vary more than one degree in any part of the stoves over the period of 24 hrs. That result was obtained by using a special mixing chamber, forced circulation and a thermostat, and the temperatures were recorded at various parts of the stoves throughout the day.

The Burnt Core Troubles

It appeared that the author had had considerable trouble in connection with the burning of cores and moulds. Having conducted experiments on stoves and having had something to do with the building of them, Mr. Smith was of opinion that the trouble was due more to the construction of the stoves than to anything else. One did not need limits anything like so fine as one degree of variation, up or down, for core or mould drying, but one did need a reasonably even temperature and a certain amount of pressure. He had proved beyond question by many experiments that, if one imposed a strong induced draft on a stove, the temperature would be uneven. If there were a strong pull on the chimney, or if there were a fan on the outlet, the hot gases would follow a more or less straight line from the inlet to the outlet of the stove, and in that line there would be burning, whereas in other parts of the stove there would be ineffective drying. Another advantage of the pressure system was that the resistance set up in the stove caused a distribution of the heat entering the stove; there was also to some extent a mixing of the hot gases entering with those already in the stove, and that prevented the temperature rising sufficiently to burn the contents. Again, there was a penetrating effect on the cores or moulds, which was absent if a partial vacuum was created by an induced draft. With regard to the possibilities of burning moulds or cores, there were stoves working in Manchester which had dried three batches of medium-size moulds at a temperature approaching 600 deg. Fah. (316 deg. C.) in 8 hrs.

Pressure System of Drying

Dealing with oil-sand cores, he said that, with a proper pressure system and reasonably good alignment of inlet and outlet, it was possible to dry cores of sizes varying over a very wide range without damaging the smaller cores, whilst at the same time drying the larger ones perfectly. Evidently the type of continuous stove used in this country was different from that referred to by the author. Not only had we no re-circulation, but we actually divided the drying period, took away the saturated air, and took the cores into a second chamber, and reintroduced fresh air, so that we obtained a result absolutely opposite to that of re-circulation. Theoretically, it would appear that, by re-circulation, one was taking the air back to do what it had omitted to do in the first place; it seemed better to make the air do its work the first time, however, and to finish the work with a fresh supply of air if necessary. In the continuous stove we could go still further than in the stationary stove in regard to variation of sizes of core, and it had been demonstrated that a core weighing $\frac{3}{4}$ oz. or less and a core weighing $\frac{3}{4}$ cwt. could be dried satisfactorily on the same shelf, in a continuous stove; he did not think that was possible in a stationary stove.

Clay, Water and Oil-Sand Cores

DR. H. NIPPER (Technical High School, Aachen, Germany) referred to some experimental work he had carried out to ascertain whether or not the addition of a certain amount of clay and of water to oil-sand cores would be useful, because sometimes clay and water were added to oil-sand cores in the foundry, with the idea, he believed, of making the cores stronger. He had found that in the dry state the strength was very much reduced, to nearly half as much as without clay and water; it did not decrease so very much in strength with water alone as with water and clay. This, he believed, was easy to explain, because when one dried a core, one drove out the water and afterwards oxidised the oil, and the oil bound the grains together. When the water was driven out, however, at a time when the outside of the core had already been oxidised and the core possessed a certain strength, the steam coming out would break up the connection between the little grains, and so the strength was reduced again. It might be that in some cases where it was not necessary to have a very strong core in the dry state, but where certain strengths were necessary in the green state, it might be advisable to add a certain amount of clay, for it was found that in a green state the oil cores mixed with water or especially when mixed with water and clay were much stronger than pure oil-sand cores.

Optimum Strength related to Water Content

MR. A. TIPPER, commenting on Dr. Nipper's remarks as to the effect of water, and possibly clay, on oil-sand cores after baking, suggested that the fine clay material absorbed the oil, and for this reason one did not get anything like the same amount of oil available for bonding the sand grains together as when using a clean silica sand. This has been proved experimentally in various Papers on the subject, and would mask the true effect of water additions.

The speaker had carried out a number of tests, using an oil-bonded, clean silica sand, with increasing water additions. The baked strength increased to a maximum and then decreased again with further water additions. That, of course, was not "green bond" but dry strength.

The essential factors in drying appear to be:—(1) Temperature control; (2) circulation of hot air, and (3) an adequate supply of oxygen in the core stove.

The author had not dealt with the fact that different materials require different percentages of oxygen during baking, in order to obtain the best results; variation in degree of oxidation

* See FOUNDRY TRADE JOURNAL, July 12, pages 21-23.

required was a matter which must be considered. The author's remarks concerning the effect o water during baking were most interesting, but needed consideration with discretion, and probably there would be further developments of the theory that the drying or baking of moulds and cores occurred in three stages.

Size-of-Mould Factor

MR. W. J. MOLINEAUX suggested that the points with regard to the relative conductivity of water and sand, and also iron reinforcement, had not been fully appreciated by foundrymen. Perhaps, however, in actual practice one did not reap such advantages as one would imagine from a glance at the Paper. It was rather unfortunate that some comparative results obtained from the type of stove outlined in the Paper, and from the standard type of hot-air drier, were not given. Although the principle might apply to moulds of thick section, in which the moisture was encouraged to migrate to the surface of the mould and to become evaporated, one could not quite imagine that that occurred in the oil-sand core, and the author should have differentiated between the two types of material being treated. In many foundries moulds of very widely varying thicknesses of section had to be treated simultaneously, and one would imagine that it was pretty well impossible to economise in drying time where such large variations in thicknesses of section had to be dealt with at one time, though it might be possible on many occasions, or in some particular foundries where specialised work was dealt with, to effect some little economy in time.

It was mentioned in the Paper that continuous-drying ovens had achieved success. But one could not visualise a type of continuous oven in which the three-stage drying system could be applied without considerable complications.

Water and Oil-Sand Practice

MR. J. H. COOPER, commenting on Dr. Nipper's remarks concerning water in core sand, said that wet sand was not used in Germany if it could be avoided, because there were so many compositions of core oil—dextrine, linseed oil and a hundred and one others—and the system was to dry all the sand if possible, using the large sand in order to minimise the amount of core oil to be used. If one used a bond to give green-sand bond, using loam or anything else, the amount of core oil necessary increased by leaps and bounds. He believed German foundrymen objected to water because it boiled on the edge, so that one did not get a smooth surface. They used dry silica sand, as little fine sand as possible, and secured very easy and quick cleaning; the finish was definitely good. When water was used, instead of getting a straight bond, one obtained an emulsion, which caused endless trouble.

DR. NIPPER said that water might help to give better distribution of the oil if there were a very small amount of oil, but that was about the only good it could do. He agreed that clay absorbed a certain amount of the oil and prevented very uniform distribution of oil.

Higher Drying Temperatures Advocated

MR. W. WEST (Leyland Motors, Limited) asked what the author had meant to convey by his statement that at 500 deg. Fah. (260 deg. C.) the qualities of linseed oil were destroyed. In this connection Mr. West referred to some direct work carried out by Dr. J. Newton Friend and himself four years ago on linseed oil, in which it was found that at 500 deg. Fah. the linseed oil polymerised and the molecular weight was increased 12 times. Applying that in practice, a foundryman would find that drying was very greatly accelerated. So that the statement in the Paper with regard to the destruction of the qualities of linseed oil at 260 deg. C. might be somewhat misleading to foundrymen, inasmuch as it was, or should be, a fundamental principle among foundrymen that the greater the amount of volatile matter that came off in the core stove the less remained to come away in the mould. Foundrymen need not be so diffident about raising drying temperatures; if good linseed oil were used the cores would not disintegrate, but would be more permeable than cores dried at lower temperatures; furthermore, there would be less blowing of the metal in the moulds. He asked, therefore, for some explanation or amplification of the author's statement.

On the proposition of the PRESIDENT, a hearty vote of thanks was accorded to the author.

The Mersey Tunnel

LIGHTING AND VENTILATION

The Mersey tunnel, connecting Liverpool with Birkenhead, was officially opened on Wednesday last. The ceremony is referred to elsewhere in this issue. From time to time we have referred to the progress made in this work and to the equipment used. Through the courtesy of the General Electric Company we are now able to give the following brief particulars concerning the lighting of the tunnel.

Lighting Equipment

The extent to which electricity is used may be gauged from the fact that nearly 600 miles of wires and cables were used. The central-lighting feature at each entrance, both at Liverpool and Birkenhead, has been contrived by Osira lamps housed in large bowl fittings, 10 ft. dia., mounted on tall pylons, some 60 ft. high. Each of these units is equipped with ten Osira lamps alternatively spaced with 500W Osram gas-filled lamps, the necessary chokes, condensers, etc., for the lamps and controlling gear for various circuits being conveniently housed in the columns. In addition, five smaller fittings of a similar type to those described above are mounted on pylons approximately 40 ft. in height with bowls 5 ft. dia., in which are eight 500W Osram gas-filled lamps. The fittings have been so designed that should Osira lamps be adopted in the future the change over can be made without any great expense. The part of the pylon projecting above the bowl is illuminated by means of nine rings of Osram architectural lamps, aggregating some 250 lamps. Each ring consists of a number of curved lamps, 14¼ in. long, having a radius of 17¾ in. These are sandblasted on the lower side to reflect the light in the direction required. A specially-designed channel for mounting these holders has been included, which makes the removal of the lamps for cleaning an easy matter. On the summit of the column is mounted a large opal spherical fitting containing three 500W Osram gas-filled lamps.

The lighting of the various toll booths and offices at the entrance is carried out by a system of special chromium-plated troughing. There are 104 sections of this troughing wired for 5-amp. plugs with 3-pin socket fixing to accommodate Osram 20-watt Pygmy lamps, a number of which are arranged at 2⅜-in. centres.

Ventilating Equipment

Part of the ventilation of the tunnel was carried out by the Sturtevant Engineering Company, Limited, who have now recorded their activities in this connection in an attractive booklet. This firm supplied fourteen fans, all of the "Superblade" type, the chief characteristics of which are as follow:—(1) High efficiency through a considerable working range; (2) quietness of running and absence of vibration due to air impulse; (3) reasonably high speed; (4) minimum of space occupied for a given output and efficiency; (5) suitability for running in parallel if necessary, to give increased output; (6) non-overloading power characteristic.

High efficiency is essential because of continuous running, a small decrease in the power consumed per fan representing a big annual saving in money. Quiet running and the absence of vibration is vital when the fans are housed in buildings which are in important business districts where any noise or vibration might cause annoyance in neighbouring premises. High speed is of advantage in reducing the size and cost of the fan and driving gear. The reduction in space occupied by the fans is a primary factor in keeping down the size and cost of the ventilation buildings, and in this respect the Sturtevant "Superblade" fan shows to very great advantage as compared with large diameter fans of similar capacity and efficiency. Although the fans are not at present being run in parallel, they are particularly suitable for running in this way if future increase in traffic calls for more air than is now being provided. The non-overloading characteristic of the "Superblade" fan is of special interest. The power absorbed rises to a maximum at about the point of maximum efficiency and then falls off, so that even under "free inlet and outlet" conditions where all other centrifugal fans (excepting those with a very pronounced backward curvature of the blades) take their maximum power, the power taken by the "Superblade" fan actually decreases, and a motor installed to suit the normal working conditions cannot be overloaded.

The fans supplied vary in size according to the desired duty, the two largest fans each being rated for an output of 577,000 cub. ft. of air per min. when running at 170 r.p.m. At this speed the power taken is about 190 b.h.p. Each fan is driven through reducing gear by a 2-speed squirrel cage motor on a 440-volt, 3-phase, 50-cycle supply, and through an hydraulic coupling to allow of speed control. The driving motors are interlocked with the main dampers in the ducts leading to the tunnel, in order to ensure that the fans can only be started with the dampers closed, when the power taken is a minimum. The aggregate capacity of these fans is stated to be 3,378,000 cub. ft. of air per min., or nearly 7,000 tons of air per hr.

Gearing for Ventilation Equipment

The speed-reducing gears which operate between the electrical and aerodynamical units in the six large ventilation stations were designed and manufactured by Messrs. David Brown & Sons (Huddersfield), Limited, to the order of Messrs. Metropolitan-Vickers Electrical Company, Limited, Manchester, and they represent the very latest practice. In all, 30 complete gear units were supplied. An outstanding feature of the speed reducers is their remarkable compactness for the duty involved. This has been achieved by the extensive use of high-tensile steel alloys for the gears, whereby a high load-carrying capacity is obtained and the size of the whole unit can be reduced. The spiral bevels employed are made from nickel-chrome-molybdenum steel heat-treated, after cutting the teeth, to a tensile strength of about 100 tons per sq. in., and all pinions are forged solid with their respective shafts. Solid forgings have also been employed for the helical wheels, which are made from high carbon steel except in the case of the large wheels used with the combined units, which are of cast formation with "H" section arms.

The Story of the Mersey Tunnel

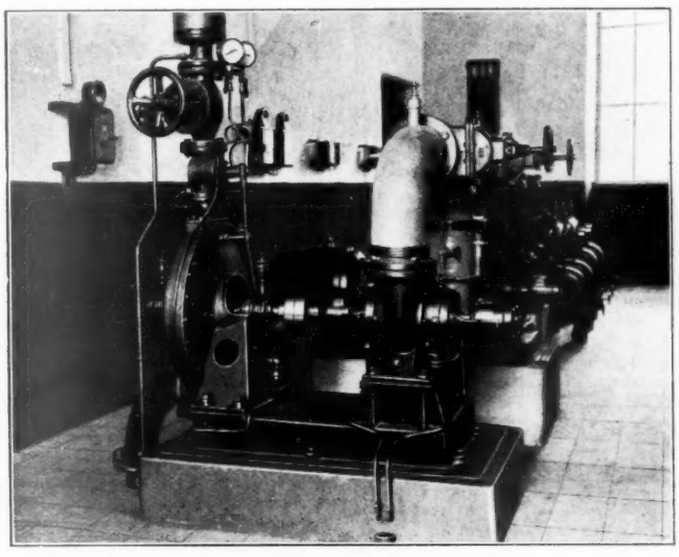
Messrs. Charles Birchall & Sons, Limited, 17, James Street, Liverpool, have published, under the authority of the Mersey Tunnel Joint Committee, a finely-illustrated brochure entitled "The Story of the Mersey Tunnel, *officially named* Queensway." The contents include portraits of many people actively connected with the work on the tunnel. There are also numerous illustrations taken during the various stages of construction. The text opens with a historical survey covering the period 1801 to 1921, and goes on to record the genesis of the scheme (1922

(Concluded on page 60.)

Small Turbine Units

ADAMSON "ROTH SYSTEM"

In chemical or other works where small supplies of power are required for pumping, operating fans or generating electrical energy, the Adamson "Roth System" turbines have a wide application. These turbines, which are of the impulse type, have been designed in sizes from 2 h.p. upwards, with speeds varying from 1,500 to 5,000 r.p.m., and are designed for a working pressure of from 25 lbs. per sq. in. upwards and allowing a back pressure up to 40 lbs. per sq. in. They can be driven with dry saturated steam or with superheated steam; in the former case, however, it is always advisable to instal an effective steam dryer which should be placed as near as possible to the turbine. These machines are made in three series by Daniel Adamson & Company, Limited, Dukinfield. Series T.D. and T.P.R. cover a range from 80 to 500 h.p., Series T.P. from 80 to 160 h.p. and Series T.V. and T.S. from 2 to 40 h.p. It is the last with which we are here concerned.



THE T.V. TURBINE DRIVING HOT-WATER PUMP.

These turbines are radial flow with a single nozzle in special metal and also a single row of blades. The steam, after having passed through the rim of the wheel, is re-directed two or three times through appropriate channels in order to impart additional energy to the rotor, and then to be finally exhausted. By this means two or three stages of velocity according to the conditions required can be achieved. In the majority of cases these turbines do not require a governor, but where necessary one of a very simple construction, composed of an eccentric mass, working on the usual governing principle, can be fitted.

By reason of the circumferential speed of these turbines being limited to a certain figure, the rotor is made of special steel mounted on a forged-steel shaft. The blades are of phosphor-bronze, or other suitable metal, riveted to the wheel and provided with a suitable shroud, correct balance being obtained when the rotors are bladed and riveted up.

THE FIRST of the four propellers for the new Cunarder No. 534 was taken aboard the steamer "Copeland" at London Docks last week for shipment to Clydebank. It was built by the Manganese Bronze & Brass Company, Limited, weighs 35 tons, has 118 sq. ft. of surface, and four blades.

A New Light Alloy

Under the name of Ceralumin "C," Messrs. J. Stone & Company, Limited, of Deptford, London, have introduced a new light aluminium alloy which has been developed to meet the demand for an alloy of low specific gravity and high strength, combined with good casting properties. The composition of the alloy, which is covered by British Patent No. 403,700, is as follows:—

Copper	2.5 per cent.
Nickel	1.5 ,,
Magnesium	0.8 ,,
Iron	1.2 ,,
Silicon	1.2 ,,
Cerium	0.15 ,,
Aluminium	Remainder

From this it will be seen that Ceralumin "C" is a complex alloy of aluminium, the most novel feature being the presence of cerium. Investigations in the company's laboratories have established the fact that, in addition to its refining action on the macrostructure, cerium allows the beneficial mechanical effects of a high iron content to be obtained by suppressing the embrittling iron-aluminium constituent which is otherwise liable to be formed. In addition, the small amount of cerium also confers on the alloy important advantages in the foundry; Ceralumin "C" has extremely good "running" properties and gives castings having a smooth, clean surface and an attractive appearance.

LIGHT ALLOY CASTINGS MADE FROM CERALUMIN BY J. STONE & COMPANY, LIMITED.

The heat-treatment applicable to this alloy is quite simple. The castings are maintained at the solution temperature of 515 to 535 deg. C. for 4 to 6 hrs. and then quenched in water; ageing is achieved by heating to 175 deg. C. for 16 hrs., followed by quenching in water. The risk of distortion at the solution temperature is no greater than that involved, for example, in heat-treating "Y" alloy at 520 deg. C., and careful measurements on castings having unfavourable features, such as overhung arms and bosses, have failed to detect any distortion as the result of heat-treatment.

In the heat-treated condition, Ceralumin "C" presents an excellent combination of high tensile strength at ordinary and elevated temperatures, high elastic limit and high Brinell hardness. These features are given in detail in the table, but special attention must be drawn to the very high fatigue strength (Wöhler, 20 million reversals) of ± 8.25 tons per sq. in., a quality which should prove of special interest to designers anxious to take the fullest advantage of the properties of available materials.

Ceralumin "C" is suitable for high-duty service in the form of die-castings, chill castings and sand castings, and it is anticipated that it will find a useful field of application, particularly in the aeronautical and automobile industries.

If the artificial ageing treatment is replaced by ageing at room temperature for five days, a modified form of the alloy is produced which is called Ceralumin "D." By this means a somewhat lower tensile strength is obtained, but the ductility is considerably increased. This modification of Ceralumin is intended for purposes where extra toughness is required in castings, such as for shrinking-on cylinder heads where heavy stresses may be set up and a little "give" in the casting is essential.

	0.1 per cent. proof stress. Tons per sq. in.	Maximum stress. Tons per sq. in.	Elongation. Per cent.	Brinell hardness number.
Chill Cast:				
Fully heat-treated	21–24	23–27	1.0	130–140
Quenched and aged 5 days at room temperature	13–14	19–21	4–6	98–101
No heat-treatment	11–12	13–14	1–3	67–77
Sand Cast:				
Fully heat-treated	18–20	19–20	0–1	130–140
Quenched and aged 5 days at room temperature	11–13	14–16	1–3	98–104
No heat-treatment	—	8.5	0–1	72

Iron and Steel Output in June

The British Iron and Steel Federation states that there were 101 furnaces in blast at the end of June, the same number as at the beginning of the month, three furnaces having gone into blast and three having ceased operations. Production of pig-iron in June amounted to 515,700 tons compared with 527,900 tons in May and 345,600 tons in June, 1933; the daily rate thus showed an increase of 1 per cent. compared with the previous month. The production includes 135,500 tons of hematite, 245,800 tons of basic, 112,400 tons of foundry and 9,900 tons of forge pig-iron. The output of steel ingots and castings amounted to 757,500 tons compared with 780,000 tons in May and 568,800 tons in June, 1933.

THE NORTH EASTERN MARINE ENGINEERING COMPANY, LIMITED, Wallsend-on-Tyne, is prepared to instal new engines in existing ships on deferred terms. It suggests that one of the most effective ways of modernising tonnage is to fit superheaters to the propelling machinery.

Sheffield University Degree Course in Foundry Practice

As previously announced in our columns, a course in foundry practice leading to the Degree of B.Met. (Founding) has been inaugurated at the University of Sheffield and will commence in the autumn of the present year.

The course has been inaugurated at the suggestion of the Institute of British Foundrymen. A special Sub-Committee of the Institute has been engaged actively in advising the University and Prof. Andrew in connection with the inauguration of the course, and is also approaching the industry with a view to enlisting financial support.

In order that the scheme may be launched on a satisfactory financial basis, it is desired to receive promises of support for a period of seven years. Several such promises have already been received, and additional donations have been forwarded by a number of firms.

We have pleasure in giving the first list of subscriptions and donations:—

Name.	Annual subscription. £	s.	d.
English Steel Corporation and Vickers-Armstrongs	50	0	0
Stanton Ironworks Company, Limited	50	0	0
Imperial Chemical Industries, Limited	26	5	0
Thos. Firth & John Brown, Limited...	25	0	0
Hadfields, Limited	25	0	0
Newton Chambers & Company, Limited	25	0	0
Sheepbridge Coal & Iron Company, Limited	25	0	0
United Steel Companies, Limited ...	25	0	0
Bradley & Foster, Limited	15	15	0
F. H. Lloyd & Company, Limited, Wednesbury	15	0	0
Sheepbridge Stokes Centrifugal Castings Company, Limited	15	0	0
Midland Motor Cylinder Company, Limited	10	10	0
Shell-Mex & B.P., Limited	10	10	0
Bagshawe & Company, Limited, Dunstable	10	0	0
David Brown & Sons (Huddersfield), Limited	10	0	0
Entwisle & Kenyon, Limited, Accrington	10	0	0
Ealing Park Foundry, Limited, London	5	5	0
Newman, Hender & Company, Limited, Stroud	5	5	0
Mr. Victor Stobie, Harrogate ...	5	5	0
British Northrop Loom Company, Limited, Blackburn	5	0	0
British Pigirons, Limited, London ...	5	0	0
Stokes Castings, Limited, Mansfield ...	5	0	0
S. Russell & Sons, Leicester	3	3	0
Foundry & Engineering Company, Limited, West Bromwich	1	1	0
Total promises of subscriptions for seven years	£382	19	0

Donations

Special donation—Sir Robert Hadfield, Bt., F.R.S., £5,000.

	£	s.	d.
Clyde Alloy Steel Company, Motherwell	15	15	0
Fulwood Foundry Company, Limited, Mossend, Scotland	15	15	0
Grayson, Rollor & Clover Docks, Liverpool	10	0	0
John Harper & Company, Willenhall...	10	0	0
Gimson & Company (Leicester), Limited	5	5	0
Grangemouth Iron Company, Falkirk	5	0	0
N. Hingley & Sons, Limited, Dudley	5	0	0
Members of the Institute of British Foundrymen	55	18	0
Total	£122	13	0

Promises of Gifts of Plant, etc.

Augusts, Limited, Halifax.
Constructional Engineering Company, Limited, Birmingham.
Newman Hender & Company, Limited, Stroud.
Mr. Victor Stobie, Harrogate.

Further subscriptions for a period of seven years are required, and the industry is invited to accord financial support and thus ensure the success of a scheme which will have far-reaching and beneficial effects upon the industry.

The National Physical Laboratory

A LIGHT WAVE AS UNIT OF LENGTH

Tentative proposals have been made in recent years to adopt the natural standard of length afforded by the length of a wave of light as a basis for defining the fundamental units of length. In order to determine the possibilities of this proposed change, the national laboratories of a number of countries have been urged by the International Committee of Weights and Measures to promote investigations with the object of formulating the conditions necessary for the establishment of such a definition. One most important part of this problem is to find the relationship between the wave-length of light and the present fundamental units, respectively defined by the Imperial Standard Yard and the International Prototype Metre. This work has recently been completed at the National Physical Laboratory, and the results have just been published in the Philosophical Transactions of the Royal Society in a Paper entitled "Determinations of the Fundamental Standards of Length in terms of Wave-Lengths of Light," by J. E. Sears, jun., C.B.E., M.A., and H. Barrell, B.Sc.

It is well known that light is propagated through space by minute waves similar in character to those used in wireless communication. Certain rays, appearing in the spectra of gases and metallic vapours, are known to consist of waves which are remarkably uniform in length, the red ray obtained by interposing a red filter in front of a cadmium lamp being especially good in this respect. It is in terms of waves of this red ray of cadmium that the yard and metre have been measured at the Laboratory.

The length of a wave of light in air is subject to variations, owing to the normal changes in atmospheric conditions, unless the air is under accurately-controlled conditions of temperature, pressure, humidity and composition. But in a vacuum the wave-length may be regarded as invariable, and is, in fact, a true natural constant. Therefore special precautions have been taken in the apparatus installed at the Laboratory to allow the important measurements of length to be made both in air under precisely-controlled conditions and also *in vacuo*. The values obtained at the National Physical Laboratory for the yard and the metre, in terms of waves of the cadmium red ray *in vacuo*, are: 1 yard = 1,419,818.31 wave-lengths; and 1 metre = 1,552,734.52 wave-lengths. The accuracy of length determination obtained for measurements in terms of light waves is between one and two parts in a hundred million, corresponding to an uncertainty in the yard length of less than a millionth part of an inch. In this connection it may be of interest to mention that a recent intercomparison of two standard bars measured in terms of wave-lengths of light by entirely different methods in this country and in Germany has shown agreement between the measurements to within one part in a hundred million.

Among the advantages which may be obtained by establishing a wave of light as the basis of definition of the fundamental units of length are, first, the increased precision of ascertainment of length, which is at least five times better than that now possible with the existing standards and, second, the avoidance of the risks of variation and damage associated with the use of all material standards of length. As showing the risk of such variation there is reason for believing that the present Imperial Standard Yard has possibly shortened by as much as two ten-thousandths of an inch since it was originally legalised in 1856.

The proposed change to the new basis would not appreciably affect practical everyday measurements of length, which would still, as at present, be made by means of material standards. The important feature is that these standards could in future be verified at any time, and at any place where the necessary apparatus was available, in terms of a natural, invariable and easily-reproducible unit of length.

The practical importance of this refinement of accuracy is obvious when it is remembered that present-day mass-production methods demand perfect interchangeability of parts; this means that the dimensional error permissible in manufacture is extremely small. The Laboratory is frequently called upon to certify master gauges for such work to one-hundred-thousandth of an inch, and its own standards in consequence must be maintained to a still higher accuracy.

The Mersey Tunnel

(*Concluded from page 58.*)

to 1924), problems of finance (1924 to 1925), and Parliamentary approval of the scheme (August 19, 1925). The remainder of this section (Part I) is devoted to the progressive stages of construction. Part II is devoted to the "Acquisition of Property." Part III refers to "The Tunnel Makers," and includes notes on the leading contracting firms. Part IV, by far the largest section, is devoted solely to "Engineering." Parts V and VI deal with "The Ventilation of the Tunnel" and "The Ventilating Stations." Part VII is devoted to "The Ventilating Machinery," and the last Part (VIII) embraces "General Equipment." Copies of this volume can be obtained from the publishers at the price of 5s. net per copy (5s. 6d. by post).

Industrial Accidents

Under the Factory and Workshop Acts, the Home Office has issued "Industrial Accidents: Descriptions of Certain Accidents notified by H.M. Inspectors of Factories, vol. V, July 1. 1934." This volume, which is issued quarterly, may be obtained from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2 (price 3d. net). The present issue includes descriptions of the following accidents: Explosion of air receiver; explosion inside an electric motor; explosion of scrap metal; casting of copper—explosion; escape of molten metal from cupola; explosion at suction gas plant; explosion of gas cooler; gassing—blast-furnace plant.

Irish Aluminium Company, Limited

The full prospectus of the Irish Aluminium Company, Limited, published in Dublin recently, indicates that the new factory will engage in the manufacture of domestic aluminium ware, plated table ware, electrical hot-plate working utensils, dairy utensils and all descriptions of aluminium articles and parts, either cast, spun or pressed, for the domestic, chemical, food, dairy, motor and electrical trades. The estimated turnover of the company is £35,000 per annum, on which a net profit of at least £2,000 is anticipated, sufficient to pay the dividend on the preference shares three times over. The cost of the factory buildings and plant and equipment is estimated at £10,000, leaving £18,000 for working capital. Mr. F. P. Webster, managing director of the Midland Metal Spinning Company, Limited, Wolverhampton, has been appointed managing director of the new company. In accordance with the terms of the managing director's agreement, the new company will have the benefit of the extensive technical and manufacturing skill of the Midland Metal Spinning Company, Limited, and the Midland Metal Diecastings, Limited. Dr. J. F. Crowley is the chairman of the company.

Coke Research*

By William Davidson, B.Sc., A.I.C.

Introduction

The first coke was made by carbonising coal in holes dug in the ground. The coal, in a conical pile, was covered with small coke and turf and was ignited at an opening left at the bottom. Since much of the coal itself was burned to supply the heat necessary for carbonisation, the process proved very wasteful and was soon replaced by Beehive ovens. These, as the name implies, were shaped like beehives and were worked in batteries consisting of about 50 ovens each. The coal was introduced through an opening at the top and kindled near the bottom of the oven. All the volatile products were burned when they reached the surface of the coal, a special air inlet being arranged for this purpose. Coking for a normal oven charge of 5 tons required about four days, and all the by-products and about 15 per cent. of the coal were burned. The coke, still in the oven, was then quenched.

In 1880 the first of the by-product ovens were erected. Coppée, with his rectangular ovens, 30 ft. long, 3 ft. 6 in. high and from 16 to 20 in. wide, carbonised 6 tons of coal in 36 hours, by utilising, as a source of heat, the gaseous products produced, and burned these in flues arranged alongside the ovens. This constituted a great advance, as no coke was burned during the process, and tar, ammonia, etc., were recovered. Another novel feature of the Coppée oven was the method of quenching. The coke was pushed out by means of a ram and was quenched outside the oven. From this oven has been evolved the highly-efficient by-product ovens of to-day. These ovens have a capacity of 20 to 28 tons and the coking period lasts only 12 to 18 hrs., the output from one oven being equal to that from over 30 beehive ovens. Only about 40 per cent. of the total gas produced is required for heating the ovens, this high efficiency being secured by a system of regenerators which are heated by the waste gases on their exit from the heating flues. The air required for burning the gas is preheated by passing through these regenerators. The surplus gas is of good quality and can be used for domestic and industrial heating. At some of the most modern coking plants the total gas produced is sold and the ovens are fired with low-grade gas, such as producer or blast-furnace gas.

Object of the Scottish Coke Research Committee

The chief work of the Scottish Coke Research Committee has been the study of methods whereby the quality of Scottish metallurgical cokes might be improved. The initial stage in this investigation was the examination of a large number of coals and blends, to determine if their properties could be correlated with those of the corresponding cokes. Special attention was given to the determination of the plastic ranges and the volatile matter evolved when coking coals and blends were heated at various rates. The coals and blends were coked in bags placed in the normal oven charge or in the small-scale experimental oven, the most important results being confirmed by making full-scale oven tests. The shatter indices of all cokes were determined.

Methods of Examination of Coals and Cokes

The Shatter Test.—The shatter test, as adopted by the Midland, Northern and Scottish Coke Research Committees, was used to determine the resistance of the cokes to breakage. From the time that coke leaves the screens at the coking plant until it has been charged into the furnace, it is subjected to a series of drops. These drops are considered to be reproduced, on an average, by the four 6-ft. drops of the shatter test. This test, showing the liability of a coke to form smalls when it is dropped, gives a measure of, perhaps, the most important quality of metallurgical coke.

Apparatus.—The standard shatter-test apparatus consists of a box 18 in. in width, 28 in. in length and approximately 15 in. in depth, supported above a rigid cast-iron or steel plate not less than ½ in. in thickness, 38 in. in width and 48 in. in length. The inside of the bottom of the box when in its highest position should be 6 ft. above the plate. The bottom of the box consists of two doors hinged lengthways and latched so that they will swing open freely and not impede the fall of the coke. The plate is surrounded by 8-in. boards to prevent any loss of coke. The box should be so suspended that it can be lowered to a convenient level for filling to minimise breakage of coke when filling. A convenient form of the shatter-test apparatus is shown in Fig. 1.

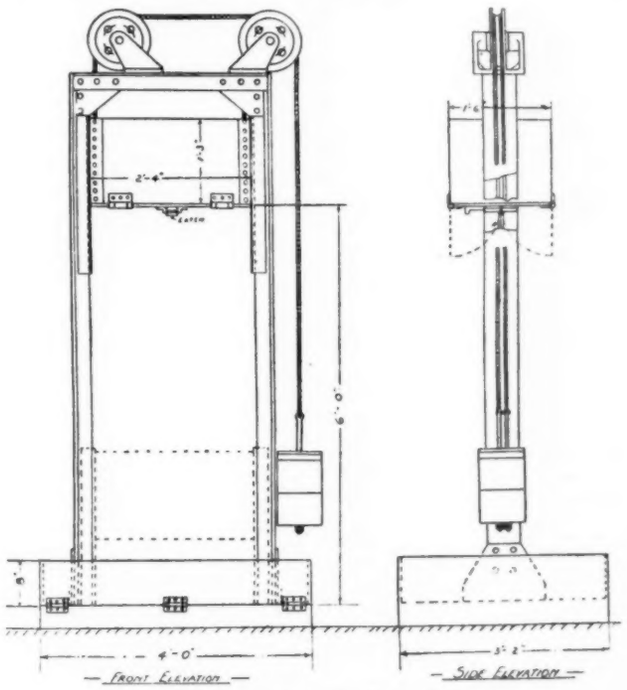


FIG. 1.—STANDARD SHATTER TEST APPARATUS.

Screens.—For determining the breakage of the coke sample, square-mesh screens with the following openings are used:—2 in., 1½ in., 1 in., ½ in. These screens should be machine-stamped from mild-steel plates with a limit of error of $\frac{1}{32}$ in.

Procedure.—Fifty lbs. of coke all over 2 in. are placed in the box of the shatter-test apparatus, the coke levelled, the box raised, and the coke dropped on to the plate. The box is then lowered and all the coke shovelled into it indiscriminately, but taking care to avoid breakage. The box is then raised and the coke again dropped. When the coke has thus been dropped four times in all, it is screened by hand in such a way that any piece which can pass through the screen in any position shall be counted as undersize, and the weights of coke of each grade shall be determined to the nearest ounce.

Statement of Results.—At least three tests are made, and the results stated as percentages (given to one decimal place), remaining on the 2-in., 1½-in., 1-in. and ½-in. screens. The shatter indices reported are the average values of the percentages retained on the 2-in. and 1½-in. screens, and are given to the nearest whole number only.

Heat-Treatment of Coals.—When a coking coal is heated progressively, it softens at a temperature of about 320 to 400 deg. C. Active decomposition of the coal substance with rapid evolution of gas then occurs. The coal remains plastic until a temperature of from 450 to 550 deg. C. is reached. At this temperature of the end of the plastic range the rigid cellular semi-coke contains about 50 per cent. of the total volatile matter content of the coal. The evolution of the voltatile matter and the shrinkage of the semi-coke continues until about 950 deg. C.

The coals used for coke making vary very widely in nature. Some do not become plastic at all when heated, and can only be used for blending with strongly-caking coals. Others become plastic when heated, giving a strong coherent coke, and these can be used alone for coke making. There are others again which are too strongly caking, giving, when coked alone, weak, highly-swollen cokes, and must be blended with a diluent of non-caking coal or other material.

It has been found by Rose ("Fuel," 1926, 5,562) that there is some relation between the total volatile matter content and the nature of the coke obtained from a coking coal. Coals having high volatile-matter contents gave highly-fissured cokes, while coals having low volatile-matter contents gave blocky cokes with comparatively few fissures. Now, since it is during the period subsequent to the plastic range that the fissuring of the coke takes place, the degree of fissuring should be related to the percentage of volatile matter evolved during this period. Accordingly, it was thought that, by comparing the volatile-matter contents of the coals after heating to the temperature of the end of the plastic range, and also the nature of the cokes obtained, a more accurate correlation would be obtained.

Determination of the Plastic Limits of a Coking Coal

The apparatus employed for this determination was a modification of that used by Foxwell to determine the pressure required to force gas, at a rate of 1 c.c./min., through a plug of coal 1 cm. long, at any given temperature ("Fuel,"

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. J. Currie presiding.

1924, 3, 122). The essential difference was the addition of a differential pressure gauge, by means of which the rate of flow of gas through the system could be obtained directly at any given temperature.

The general arrangement of the apparatus is shown in Fig. 2. The method of filling the tube was the same as that described by Foxwell and is shown in Fig. 2 (A). A steel tube of $\frac{3}{8}$-in. internal diameter was used. It had saw cuts at the top and bottom at W, making two slots through which passed a metal wedge. This wedge served to counteract the expansive force of the coal and prevented it from flowing. A head of water of about 12 ft. forced nitrogen through the coal, a constant head being maintained by means of an apparatus devised by Gray (J.S.C.I., 1928, xlvii, 187T). A capillary tube was placed in the water-supply tube and the restriction adjusted to give a rate of flow of nitrogen of about 20 c.c./min. when the pressure-gauge reading was zero.

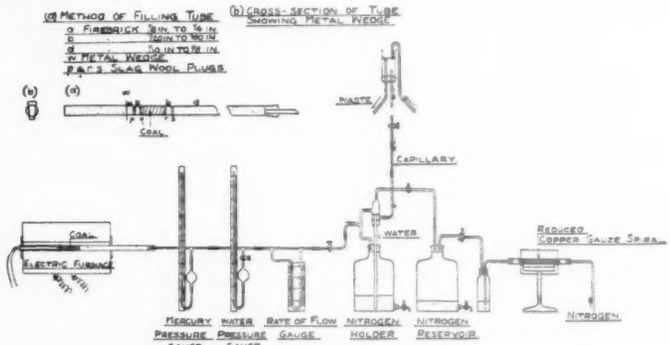


FIG. 2.—APPARATUS FOR DETERMINING THE PLASTIC LIMIT OF COAL.

The coal to be examined was ground to pass through a sieve of $\frac{1}{4}$-in. square mesh. The tube, packed as shown in Fig. 2 (A), was placed in the electric furnace, the nitrogen flow started, and the temperature raised rapidly to 250 deg. C. At this temperature the external resistance was adjusted to give the desired rate of heating. The pressure in the system and the rate of flow of nitrogen were noted at intervals of 5 deg. C.

The change of the coal to the plastic state was accompanied by an increase in the pressure of the system and a decrease in the rate of flow of nitrogen through the coal. Usually, the tube became completely blocked up, and for a time no nitrogen passed through the coal. A negative reading of the differential pressure gauge was often obtained, indicating that some of the gas evolved by the coal was passing into the nitrogen holder. The pressure was allowed to increase to a given value, 12 cm. of mercury, at which point the water flowing into the nitrogen holder was cut off. Due to the evolution of gas by the coal the pressure in the system increased very slowly. The end of the plastic range was accompanied by a sudden drop in the pressure of the system, this drop being observed from the reading of the pressure gauge. At the same time the rate-of-flow gauge gave a positive reading which increased rapidly.

In some cases the tube never became completely blocked up and nitrogen passed through the tube throughout the experiment. This occurred when poor caking coals were heated at a relatively slow rate, for example, at 1 deg. C./min. In these cases the temperature of the end of the plastic range was taken as that point at which the rate of flow of nitrogen, after decreasing to a minimum value, began to increase.

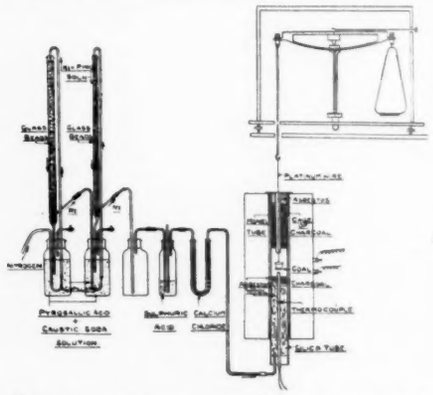


FIG. 3.—APPARATUS FOR DETERMINING THE VOLATILE CONTENT OF COAL.

Determination of the Volatile Matter Content of a Coal at any given Temperature

A method similar to that described by Audibert ("Revue de l'Industrie Minérale," March 15, 1926) was standardised and used for the determination of the volatile contents of the coals and blends at the end of their plastic ranges. The general arrangement of the apparatus is shown in Fig. 3.

About 1 gm. of finely-crushed coal, contained in a silica crucible, which was suspended centrally in a silica tube by a platinum wire of 0.008 in. diameter from a sensitive balance, was heated in an atmosphere of carefully-purified nitrogen. The method of packing the silica tube may be observed from Fig. 3. Nitrogen from a cylinder was passed into the first washer and by means of an injector the soda-pyrogallol solution was carried to the top of the absorption tower. A duplicate washer was used to ensure the complete removal of oxygen fron the gas. A rate of flow of 50 c.c. of nitrogen per min. was found to be sufficient to maintain an inert atmosphere surrounding the coal. The coal was heated at the desired rate by means of an electric furnace and the temperature was observed by means of a thermocouple placed in close proximity to the coal.

In each determination, when the apparatus had been assembled, the crucible and coal were weighed. Nitrogen was passed at a rate of about 50 c.c. per minute for 60 minutes, after which the heating of the coal at the given rate was commenced. Weighings were taken at intervals of 10 deg. C. The temperature was maintained at 950 deg. C. for about 40 minutes, after which interval there was no further loss in weight.

Blending Experiments

It was considered probable that if the volatile matter retained by a coal at the end of the plastic range could be diminished, a coke having less fissures would be obtained. This could be attained in two ways, either by adding a material having a low volatile-matter content, for example, high-temperature coke, which does not reduce the temperature of the end of the plastic range, or by raising this temperature by the addition of a coal having a higher temperature for the end of the plastic range and a lower volatile-matter content at this temperature.

Accordingly, a series of experiments were carried out in which a coking coal was blended with (*a*) a low-temperature coke, carbonised at 650 deg. C. and having a volatile-matter content of 11.8 per cent.; (*b*) a high-temperature coke, carbonised at 1,000 deg. C. and having a volatile-matter content of 1.0 per cent.; and (*c*) an anthracite having a volatile-matter content of 7.2 per cent.

The coking coal used was the same as that usually carbonised in the ovens and was the $\frac{1}{8}$-in. to 3-in. washed screenings from two very similar seams. This coal was crushed, as in normal practice, so that about 85 per cent. passed through a $\frac{1}{8}$-in. square-mesh screen.

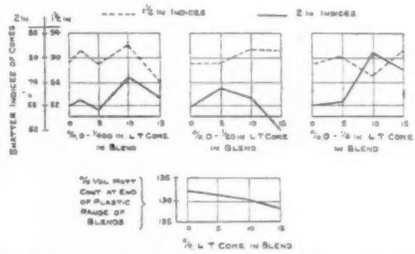


FIG. 4.—EFFECT OF BLENDING COAL NO. D.8 WITH LOW-TEMPERATURE COKE.

(*a*) *Effect of Blending with Low-Temperature Coke.*—Coal No. D.8 was blended with 5, 10 and 15 per cent. of a low-temperature coke, ground to three different sizes, namely, 0-1/400 in., 0-1/20 in. and 0-$\frac{1}{4}$ in. The most important results obtained from the examination of the blends and the resultant cokes are shown in Fig. 4.

The addition of 10 per cent. of 0-1/400-in. and 10 and 15 per cent. of 0-$\frac{1}{4}$-in. coke caused increases in the sizes, and the 2-in. shatter indices only of the resultant cokes. It should be noted that the 1$\frac{1}{2}$-in. shatter indices of these blend cokes did not differ much from that of the coke made from the straight coal. It is therefore considered that no real improvement in the coke was obtained by the additions of low-temperature coke. It is observed from Fig. 4 that 5, 10 and 15 per cent. additions of low-temperature coke lowered the volatile-matter content at the end of the plastic range by a small percentage only.

(*b*) *Effect of Blending with High-Temperature Coke.*—Coal No. D.8 was blended with high-temperature coke ground to the following sizes: 0-1/400 in., 0-1/20 in. and 0-$\frac{1}{4}$ in.

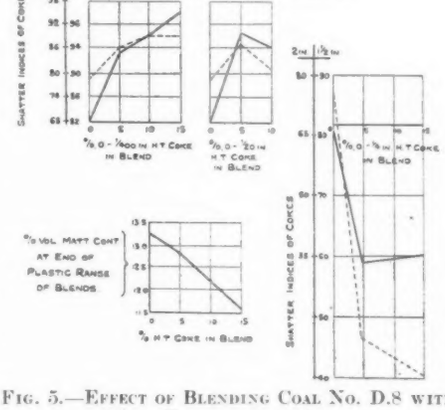


FIG. 5.—EFFECT OF BLENDING COAL NO. D.8 WITH HIGH-TEMPERATURE COKE.

The chief results are shown in Fig. 5. The addition of 5, 10 and 15 per cent. of high-temperature coke, ground to 0-1/400 in., caused a large and progressive increase in the size and resistance to shatter of the resulting coke. The 15 per cent. blend gave a remarkably large coke, which was comparatively free from fissures.

The blends of coal No. D.8 with 5 and 10 per cent. of 0-1/20-in. high-temperature coke, espe-

cially the lower percentage, gave cokes of increased size and resistance to shatter. The ½-in. shatter index of the 10 per cent. blend was comparatively low, this being due to the existence of a large number of small cross-fractures in the coke, which made it abradable.

The addition of 5 and 15 per cent. of high-temperature coke ground to 0-¼ in. gave cokes which contained a large number of cross-fractures, but practically no longitudinal fractures (perpendicular to the oven wall). These cokes gave a large percentage of breeze on handling.

Cause of Fractures

It is interesting to consider the cause of the cross-fractures in the cokes made from the blends of coal No. D.8 with the larger sizes of crushed high-temperature coke. They may be attributed to the non-homogeneity of the blends. In the case of the blends of coal with coke ground to pass a 200-mesh I.M.M. sieve, a very intimate and homogeneous mixture is obtained. The blends of coal with coke ground to pass a 10's mesh I.M.M. sieve and, to a much greater degree, the blends with the coke ground to pass a ¼-in. mesh sieve will not be so homogeneous. When the coal, after passing through the plastic stage, attains that temperature, above which further decomposition will cause fissuring, the semi-coke formed from the coal still contains about 13 per cent. of volatile matter, while the particles of high-temperature coke added contain only about 1 per cent. of volatile matter. There will be considerable shrinkage of the semi-coke formed from the coal, while no shrinkage will take place in the case of the high-temperature coke particles. The non-homogeneity of the blend will therefore cause rupturing at the surfaces of the particles of high-temperature coke. In the case of the blends of coal with the very finely-ground coke, the particles are so small that the fractures caused by them will be as small as the pores of the coke and will not weaken the coke structure. It is apparent that the larger the size of the high-temperature coke particles used in the blend, the more pronounced will be the fractures at the surfaces of these particles.

It is also important to note that the lines of weakness in the coke structure are formed subsequent to and not during the plastic stage of the coal. This is observed from the fact that the blends of coal No. D.8 with low-temperature coke, even those containing the largest size of coke particles, gave cokes which varied but little,

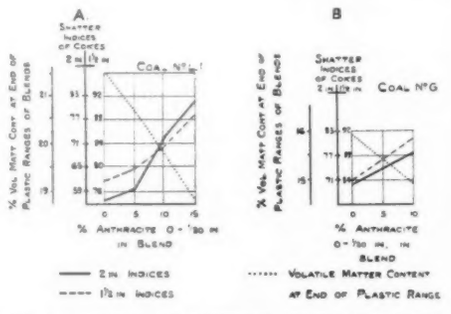


FIG. 6.—EFFECT OF BLENDING WITH ANTHRACITE

in their resistances to shatter, from the coke made from the straight coal. At the temperature of the end of the plastic ranges of the blends, the low-temperature coke particles contain 9.3 per cent. of volatile matter, while the semi-coke formed from the coal contains 13.2 per cent. of volatile matter. The difference between the degree of shrinkage of the components of these blends is not so great and will not cause as much weakening of the coke structure as was observed in the case of the blends of this coal with the larger sizes of high-temperature coke particles.

It is therefore observed that when blending coking coals with non-caking material, the lower the volatile-matter content of this material the finer must it be ground to prevent the resultant cokes from being abradable.

(c) *Effect of Blending with Anthracite.*—Several compressed oven charges of coal, No. G.2, blended with 10 per cent. of finely-ground anthracite, containing 7 per cent. of volatile matter, were carbonised. The moisture contents of the charges were from 9 to 11 per cent. and the coking periods 30 hr. to 31 hr. The oven width was 18 in. and the flue temperature 1,100 deg. C.

The results given in Fig. 6 (B) show that the reduction of the volatile-matter content at the end of the plastic range of the blend was accompanied by a corresponding increase in the resistance to shatter of the coke obtained. Similar results were obtained when coal No. L.1 was blended with 5, 10 and 15 per cent. of finely-ground anthracite containing 7 per cent. of volatile matter.

Examination of Blends of Two Scottish Coking Coals

The blends of two dissimilar Scottish coking coals were carbonised in bags, placed in a central position in a compressed charge of a 50 per cent. blend of these coals. Each of the blends contained about 8 per cent. of moisture and were coked in 36 to 38 hrs. The width of the oven was 20 in. and the flue temperature 1,100 deg. C. The chief results of the examination of the blends and the cokes made from them are given in Fig. 7.

It will be observed from Fig. 7 that there is a close relationship between the volatile-matter contents of the blends at the end of their plastic ranges for each rate of heating, and the shatter indices of the corresponding cokes. It is also significant that optimum values are obtained for the resistances to shatter of the cokes from the blends containing 20 per cent. of either of the parent coals. This very striking feature is in agreement with the results obtained by the Northern Coke Research Committee in several of their blending experiments.

An important feature of these results is that, while coals Nos. R.1 and R.6 had widely different total volatile-matter contents, 25.7 and 30.6 per cent. respectively, they gave almost the same volatile-matter contents at the end of their plastic ranges. In agreement with this latter fact, these coals gave cokes of almost identical resistance to shatter.

Cupola Testing of Cokes

The results of several preliminary cupola tests which have been made to compare the melting efficiency of a Scottish coke with that of probably the best Durham foundry coke are now described. Until recently the majority of Scottish foundries, particularly those making light castings, used only Welsh and Durham cokes. The Welsh coke used was extremely large and strong, but owing to the high cost of transport, its use was usually limited to the making up of the cupola bed. The Durham cokes were, however, also used for fusion. The quality of several Scottish cokes has been improved to such an extent that increasing quantities are being used in Scottish foundries.

The chief details of the manufacture and the analyses of the cokes are shown in Tables I and II. It is observed from Table II that these cokes, especially the Welsh coke, were of very good quality. The Scottish coke gave very high

TABLE I.—*Details of Manufacture of Cokes used for Cupola Tests.*

Coke.	Moisture in coal charge. Per cent.	Compressed or loose coal.	Mean width of oven. In.	Flue temperature. Deg. C.	Coking period. Hrs.
Welsh	9.0	L.	19	—	48
Durham	2.5	L.	21	1,000	42
Scottish	9.0	C.	18	1,100	34

TABLE II.—*Analyses of Cokes used for Cupola Tests.*

Coke.	Moisture.	Ash.	Sulphur.	Screening indices.			Shatter indices.			
				4 in.	3 in.	2 in.	2 in.	1½ in.	1 in.	½ in.
	Per cent.	Per cent.	Per cent.							
Welsh	1.3	5.8	0.9	70	85	97	93	96	98	98.6
Durham	2.8	7.0	0.7	55	85	96	90	96	98	98.9
Scottish	3.8	7.4	0.6	50	86	96	80	92	96	98.2

shatter indices for one made from compressed charged coal. Compressing a coal before coking causes a reduction of the size and the shatter indices, especially the 2-in. index, and an increase in the density of the resultant coke. This coke is, however, usually more uniform in size, and as efficient for cupola work as that made from the same coal when charged loose to the oven. It was much denser than the other cokes, and it may be seen from the results of the cupola tests Nos. 1 to 4, and 10-12, recorded in Table III, that more of this coke was required for the bed than was the case when the Durham coke was used. In the other tests, Welsh or Durham coke was used to make up the bed.

At Foundries A, B and C, ordinary types of cupolas, having only one row of tuyeres, were used, while at Foundry No. D, a balanced-blast type having three rows of tuyeres was employed.

The results given in Table III show that considerable percentages of carbon monoxide were present in the top gases of the cupolas of the ordinary type. When it is remembered that only

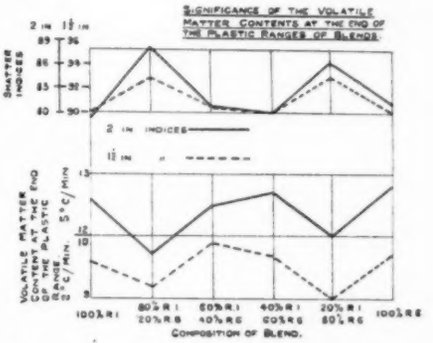

Significance of the Volatile Matter Contents at the End of the Plastic Ranges of Blends
Shatter Indices
2 in Indices
1½ in "
Volatile Matter Content at the End of the Plastic Range
Composition of Blend.

FIG. 7.—RELATIONSHIP BETWEEN SHATTER INDICES AND VOLATILE CONTENT.

33 per cent. of the possible heat is obtained when carbon is burned to carbon monoxide, the great loss of efficiency is realised. Moreover, the presence of oxygen in the melting zone has a harmful effect upon the iron.

In the balanced-blast cupola designed by Mr. Fletcher, of the British Cast Iron Research Association, the air entering the cupola through the main row bottom tuyeres is adjusted by means of valves so as to limit the percentage of free air or oxygen of the gases in the lower part of the coke bed and, at the same time, to maintain the optimum percentage of carbon monoxide

in these gases. The carbon monoxide formed just above the lower tuyeres is burned by air admitted by two or more rows of small auxiliary tuyeres.

In the Poumay cupola, used at Foundry E, the same efficient combustion is obtained by a slightly different method. The auxiliary tuyeres are arranged spirally round the circumference of the cupola, but, like the main row of tuyeres, are connected directly to the windbelt, and since valves are not fitted to the main tuyeres, the control of the air is not so simple as with the balanced-blast cupola.

Comparison of the results given in Table III of test Nos. 1 and 2, using Durham coke, with those from No. 3, when Scottish coke was used, shows that the performance of the Scottish coke was equal at least to that of the Durham coke in the ordinary-type cupola. A small increase (6 per cent.) in the quantity of coke (Scottish) used for test No. 4 resulted in a large increase of the metal temperatures.

At Foundry No. B, Scottish coke was used for fusion and Welsh coke for the bed. The metal temperatures obtained were comparatively high for the metal:coke ratios used, but this is probably due to the comparatively low percentage of carbon monoxide observed in the top gases. Improved metal:coke ratios were obtained at this foundry by the use of Scottish coke.

It is the practice at Foundry No. C to use a lower metal:coke ratio for the "fill up" of the cupola, a very high metal temperature being desired for the special castings made from the first 12 tons of metal. The average metal temperature for the first quarter of the cast was usually 1,350 deg. C. and for the remainder of the cast 1,315 deg. C.

Tests were also carried out in both cupolas at Foundry C when they had been relined, the sides in each case being made parallel. The average results obtained from these tests are recorded as test No. 7. The average results obtained from the five casts immediately before the relining of the cupola are given as test No. 6. An appreciable saving was made in the quantity of coke required for the bed. A higher average metal-temperature, even with a higher metal:coke ratio, shows that the relined cupola was more efficient. At this foundry, Welsh coke was used for the bed and Durham or Scottish coke for fusion. The average monthly values given show that the metal:coke ratios when using Durham or Scottish coke were very similar.

The chief features of the tests carried out at Foundry D using Durham coke in the Balanced-blast cupolas were the high metal:coke ratios, the low percentages of carbon monoxide and the very uniform metal temperatures. The high percentage of light scrap used at this foundry must assist greatly in the obtaining of such high metal:coke ratios. It is important to note that no reduction of the metal temperatures occurred when 50 per cent. of this Durham coke was displaced by Scottish coke, without altering the metal:coke ratio, even although a small increase was observed in the carbon monoxide content of the top gases. For test No. 10, using 100 per cent. Scottish coke, much lower metal:coke ratios were used and only slightly higher metal temperatures were obtained. This difference of melting efficiency is accounted for by the fact that the top gases contained 6 per cent. of carbon monoxide in this test of Scottish coke, while only 1.4 per cent. was present when Durham coke was used. Durham coke had previously been used in this foundry and it was found necessary to close the top (third) row of auxiliary tuyeres, and they were therefore built up. It is evident from these tests that when using Scottish coke the efficiencies of the cupolas could almost certainly be increased to the high values obtained from Durham coke by reopening the upper tuyeres or by reducing the air supplied by the main row of tuyeres at the bottom of the furnace. The latter method would, however, cause a reduction of the melting rate.

The results of the tests carried out at No. E Foundry with the Poumay cupolas show that uniform metal temperatures and very low percentages of carbon monoxide were obtained for each coke. The metal:coke ratios used for the Durham coke were higher than those for the Scottish coke. Slightly lower metal temperatures were obtained with the Durham coke. It should be pointed out that since different metal mixtures were used at each foundry no comparison is possible between the melting efficiencies of the various cupolas.

TABLE III.—*Average Results of Cupola Tests.*

Test No.	Percentage scrap.	Coke. Percentage of Welsh.	Durham.	Scottish.	Total cast. Tons.	Metal : Coke ratios. Including bed.	Excluding bed.	Melting Rate. Tons hr.	Metal Temperatures in deg. C. Average.	Min.	Max.	Per cent. CO_2 in top gases.	Per cent. CO in top gases.	Coke in bed. Cwts.	Blast press. Ozs.
Tests carried out at No. A. Foundry using an ordinary type cupola of 39 in. diameter.															
1	42	—	100	—	17	8.3 : 1	11.9 : 1	5.9	1,325	1,300	1,350	14.1	9.0	12	21
2	44	—	100	—	17	8.6 : 1	11.9 : 1	6.0	1,325	1,310	1,350	15.7	7.0	11	21
3	41	—	—	100	17	8.2 : 1	12.0 : 1	6.7	1,330	1,300	1,350	14.4	8.2	13	21
4	35	—	—	100	16	7.8 : 1	11.3 : 1	5.9	1,365	1,340	1,400	14.8	8.7	13	21
Tests carried out at No. B Foundry using an ordinary type cupola of 45 in. diameter.															
5	30	26	37	37	15	9.2 : 1	16.0 : 1	6.1	1,340	1,310	1,365	18.3	4.1	14	13
Monthly average ..	30	28	—	72	14	8.5 : 1	15.2 : 1	6.0	Temps. approx.			—	—	14	13
" " ..	30	28	72	—	14	8.0 : 1	13.2 : 1	5.9	same in each case.			—	—	14	13
Tests carried out at No. C Foundry using an ordinary type cupola of 60 in. diameter.															
6	30	20	—	80	45	9.1 : 1	13.2 : 1	11.8	1,325	1,300	1,420	14.4	9.0	30	14
7	30	25	—	75	46	10.8 : 1	14.8 : 1	12.7	1,340	1,300	1,410	15.0	8.3	23	14
Monthly average ..	30	22	78	—	44	10.2 : 1	13.8 : 1	12.3	Temps. approx.			—	—	26	14
" " ..	30	20	—	80	46	10.0 : 1	13.6 : 1	12.0	same in each case.			—	—	27	14
Tests carried out at No. D Foundry using a Balanced-Blast cupola of 54 in. diameter.															
8	50	—	50	50	29	12.0 : 1	19.2 : 1	10.4	1,315	1,300	1,330	18.2	3.0	18	10
9	46	—	100	—	31	12.3 : 1	19.2 : 1	11.2	1,310	1,300	1,330	20.6	1.4	18	10
10	50	—	—	100	37	11.4 : 1	16.4 : 1	11.5	1,320	1,300	1,340	16.6	6.0	19	12
Tests carried out at No. E Foundry using a Poumay cupola of 51 in. diameter.															
11	33	—	—	100	43	10.4 : 1	14.7 : 1	13.0	1,325	1,310	1,340	19.7	0.3	25	22
12	33	—	100	—	41	11.0 : 1	16.0 : 1	12.7	1,315	1,300	1,340	19.6	0.4	23	18

Summary

The researches made to correlate the properties of the coals and blends with those of the corresponding cokes, being the first step in the work of improving the quality of metallurgical coke, are outlined. It is during the period subsequent to the plastic range that the fissuring of the coke takes place, and the degree of fissuring should be related to the percentage of volatile matter volved during this period. Accordingly it was thought that by comparing the volatile matter contents of the coals after heating to the temperature of the end of the plastic range, a more accurate correlation would be obtained.

It is shown by means of a series of blending experiments that when the volatile matter retained by a coal at the end of the plastic range was diminished a less fissured coke was obtained.

It was found that the addition of finely-ground materials of low-volatile matter content such as high-temperature coke and anthracite, effected reductions in the volatile matter contents at the end of the plastic ranges of the blends, which were accompanied by corresponding increases in the sizes and resistances to shatter of the resultant cokes, provided that the limits of size and percentage addition of the blending materials were not exceeded. The relationship observed between the volatile matter contents of these blends and the resistances to shatter of the cokes made from them, was also found to occur in the case of binary blends of coking coals and their cokes.

Cupola Testing of Cokes.—A series of preliminary tests carried out to compare the melting efficiencies of a Scottish with a very good Durham coke in various types and sizes of cupolas are described. The performance of the Scottish coke was at least equal to that of the Durham coke in ordinary types of cupolas of 39 in. and 60 in. internal diameter, while in one of 45 in. diameter better results were obtained by the use of the Scottish coke.

In a balanced-blast cupola 50 per cent. of Durham coke was displaced by Scottish coke without altering the melting efficiency of the cupola, even although a small increase in the carbon-monoxide content of the top gases was observed. Lower metal:coke ratios were required when using 100 per cent. Scottish coke, but this was due to the fact that an increase of 4.6 per cent. in carbon-monoxide content of the top gases occurred. This difficulty might have been overcome by reopening the top row of auxiliary tuyeres which had been found unnecessary when using Durham coke. In the tests made with the Durham and Scottish cokes in a Poumay cupola, slightly higher metal:coke ratios were obtained when the Durham coke was used.

The author desires to express his thanks to the Scottish Coke Research Committee for their permission to publish this Paper, and also his appreciation of the valuable assistance he received from the cokemakers and ironfounders during the course of the work.

DISCUSSION

Quality Factors

The CHAIRMAN (Mr. J. Currie) said that Mr. Davidson had given a very complete and interesting description of the work of the Scottish Coke Research Committee, and he was interested to know of the work being carried out of such use to the foundry. Mr. Davidson had described various properties mainly based on the shatter test, but none based on the analysis of the coke or the calorific value. He would like to know how Mr. Davidson would describe a perfect coke for foundry purposes. Would he do it by analysis, calorific value or shatter test? People came along to the foundry offering coke of alleged special quality, claimed in some cases on analysis and others calorific value.

MR. DAVIDSON, in reply to Mr. Currie, said that all those things were very important in determining the value of a coke, analysis giving low ash and high calorific value. The shatter test was perhaps best, because they must have for cupola work a very strong coke; they all knew the difficulties with smalls. In some tests made with coke screened between 2 in. and 3 in. gave very good results, but it was usual to take the ordinary unscreened coke.

Ash Content and Practical Performance

MR. JOHN CAMERON said he was a member of the Scottish Coke Committee, and when Mr. Davidson was able to put the figures before the Committee he thought it would be a good idea if Mr. Davidson came into touch with the foundrymen. The Paper had dealt with trials of Welsh, Durham and Scottish cokes, and he himself had used them all. The Scottish coke was a good melting fuel, but it lacked structure and strength. The figures which had been given required to be read and studied, and he thought, when the Paper was published in THE FOUNDRY TRADE JOURNAL, they would be able to appreciate the value of them better than was possible by just seeing them on the screen. He tried some of the early Scottish cokes produced to Mr. Davidson's instruction, and found the ash pretty high; there had been an improvement, but Scottish coke was still higher in ash than Durham coke. The Paper Mr. Davidson had given them had shown that the Scottish coalmasters were all alive to the necessity of improving the fuel and the advantages of research. He wished to congratulate Mr. Davidson upon the research work which he was carrying out.

MR. DAVIDSON, in reply, said that he thanked Mr. Cameron for his remarks. He hoped eventually they would be able to produce a coke with a lower ash. He had shown on the screen some specimens with 7.2 per cent. ash which was quite low and Durham was not much less. The Welsh coke was, of course, in a class by itself.

Price and Performance

MR. J. LONGDEN said that like Mr. Cameron he thought they owed a debt of gratitude to Mr. Davidson for his Paper. He had given quite a quantity of data which was very valuable, particularly in regard to the Scotch coke. They were faced with the fact that Scotch coke could be bought at 75 per cent. of the price of Durham, that offset some of the want of efficiency of it. Mr. Davidson had stated that the Welsh coke arrives at the foundry big and strong, but he himself thought that big coke was not too good for putting into the cupola, and they did not want the trouble of breaking it. He received Scotch of medium size. He was not making very light castings with high-phosphorus irons, but was making special engineering castings from hematite and steel. The phosphoric iron stayed in the furnace a shorter time than hematite and steel. Mr. Davidson had stated that the Scottish Committee aimed at a coke which fissured as little as possible, but it seemed to him that it was not necessary that the coke should be in large pieces to find the necessary degree of hardness as he found it in small pieces. He thought that hardness was always associated with a tendency to fissure. There was one point he would like further information upon and that was in relation to the plastic change which Mr. Davidson said occurred between 300 and 450 deg. C., and which was described as a pasty range. He wondered if that was a reversible action, and if the coke was heated to, say, 500 deg. C. it came pasty again. He had examined the coke dropped from the bottom of the furnace after a casting, and on breaking found that the inside was silvery, like new coke, there was no sign of charring or burning in the centre. It was therefore clear that the coke which had assisted in the melting underwent no change in the centre, and the only burning was on the surface.

Mechanical Characteristics

MR. DAVIDSON thanked Mr. Longden for his remarks on the size of coke, and he agreed that what was wanted was a coke of uniform size. There was a large percentage between 3-in. and 4-in. size, but it must be strong. He thought there was little danger of pieces of Scotch coke being produced too large as the tendency was to reduce the width of the ovens to about 14 in. and the biggest pieces would be about 6 in. by 4 in. by 4 in. In the old type of beehive oven one obtained large lumps which had to be broken. The coal softens at just over 300 deg. C. and remains plastic until just over 500 deg. C. The action is not reversible. Continued heating of coke midway in the plastic range produces no changes, and it solidifies with the same structure as before. Mr. Longden's remarks on burning were interesting, and he agreed that there was only a surface action. Coke consisted of 50 per cent. pores and 50 per cent. of the coke was closed to the air.

Improvement Registered

MR. R. JEFFREY said he had found that the coke produced since Mr. Davidson started work had shown a great improvement, and at the foundry with which he was connected they used a large percentage of Scottish coke and found it very suitable. Prior to the investigations of Mr. Davidson and his committee they could not get Scottish coke which was suitable for their work. In the tables which had been shown, the analyses of the waste gases appeared to agree well with the coke ratios. There was one point which he had always thought needed more attention, and that was the variations of size of the coke in different trucks or consignments. He would like to ask Mr. Davidson how the manufacturers standardised; was it on the shatter test or on analysis?

MR. DAVIDSON said, in reply to Mr. Jeffrey, that variations in size from one consignment to another were due to variations in the coke substance. Usually the seam varies from one end to the other, and in order to minimise variations, several seams were used in a mixture in an endeavour to correct variations in any one. It would take time, but they hoped eventually to overcome these difficulties.

MR. EVAN ROSS said that the structure of Durham coke was more open and kept a structure of one size more than the Scotch. The Durham got more incandescent and gave better melting.

MR. DAVIDSON said that the structure of Scotch and Durham coke varied quite remarkably, due to the difference in the coal. All variations were due to the coal. Durham coal swells to a remarkable extent, about 200 per cent., but the Scottish coals swelled very little, so the Durham coke was more open and the pores larger than in Scottish coke.

A hearty vote of thanks was accorded to the lecturer.

Iron and Steel Institute

The autumn meeting of the Iron and Steel Institute will be held in Belgium and Luxemburg on September 10 to 14.

A Method of Determining the Thickness of Steel Plates and Castings*

BY GEORGE M. SHAW

A steel plate commences to corrode from the time of rolling, and this Paper deals with the necessary examination to ascertain if it is still serviceable, and the use of X-rays to make a more thorough examination of the plate than is otherwise possible, with a view to economy. A plate deteriorates at the parts away from the edges, as well as along the edges, and with ordinary methods of examination it is necessary to drill holes and gauge the thicknesses. If the plate is not rejected, such holes are subsequently filled in by means of rivets. Such methods of testing should, however, be avoided as far as possible, as, apart from the monetary loss entailed, the obvious and permanent disfigurement caused by the rivet draws attention to the fact that doubt has existed as to the reliability of the plate.

As thickness tests have frequently to be made on ships' plates, boilers, bridgework, tanks and other engineering structures, the author has for some time been engaged in trying to find other reliable methods of ascertaining the thickness, and he suggested to Messrs. N. V. Philips that possibly an X-ray method could perform the desired measurement. Such a method would have to be simple, inexpensive and easy to operate. As a result of experiments, Messrs. Philips succeeded in developing an equipment which meets those requirements.

A beam of X-rays (which, like light rays, travel in straight lines), emanating from a point, is directed on to the plate whose thickness is to be determined. Two tungsten wires placed 10 cm. apart are fixed on top of the plate, and a photographic film is pressed against the back of the plate and exposed to the X-ray beam. Since tungsten is more opaque to X-rays than iron, the image of each wire appears on the film. The source of the rays is 20 cm. from the front of the plate, so that if the distance between two shadows of the wire as measured on the film is A cm., then the distance between the tungsten wires and the film is $(2A - 20)$ cm. To obtain the thickness of the steel plate, a constant correction is deducted, since the film is not in actual contact with the plate. This correction need only be determined once for the film holders used.

A number of trial measurements on steel plates by the X-ray method were carried out in conjunction with the author in the laboratories of Messrs. Philips. The thickness of plates examined ranged from 1½ mm. up to nearly 20 mm., and, except in the case of the thinnest plate, the error was less than 1 per cent.

The arrangement of the X-ray tube is described in the Paper. The tube, with the attachment carrying the tungsten wires, is held in position by means of an electro-magnetic device, and its position is easily located in the interior of the vessel by means of a magnet or by a fluorescent screen. The complete equipment is extremely simple, and there is no difficulty in carrying out the work; there are no complicated adjustments to be made. No knowledge of photography is required to carry out the work; over- or under-development of the film is of practically no importance to the measurement, and if a result is urgently required, the thickness of the plate can be determined before the film is dry; the whole procedure, therefore, can be carried out in a few minutes. Tests on ship plates carried out with the apparatus are described. It is considered that in many cases the thicknesses of castings could advantageously be checked by the system described by the author.

* Abstract of a Paper presented to the Institution of Civil Engineers.

This Week's News in Brief

Trade Talk

THE NEW SECRETARY and registered offices of the Institution of Welding Engineers are Mr. F. Stoyle, secretary, Institution of Welding Engineers, Limited, 7-8, Holborn Hall, Gray's Inn Road, London, W.C.1.

A GOODLY NUMBER of the 50 locomotives ordered from the North British Locomotive Company, Limited, Glasgow, by the L.M. & S. Railway Company have recently been completed and delivered. The balance will be completed after the end of the holiday period.

LAST TUESDAY an outbreak of fire occurred in the yard of Messrs. William Simons & Company, Limited, Renfrew, where a large number of patterns were stored. The fire spread very rapidly, but the fire brigade managed to confine the fire to the area where it started.

THE LARGE NUMBER of doors constructed of stainless steel used in the Mersey Tunnel, as well as steel stairways at emergency exits and elsewhere, were manufactured and installed by Messrs. Fredk. Braby & Company, Limited, Eclipse Works, Petershill Road, Glasgow.

FIRE BROKE OUT in the moulding shop of Torwood Foundry, Larbert, on Friday last, a wooden partition separating the rain-water section from the general section being involved. The outbreak was dealt with by the foundry brigade before it had assumed a serious aspect, the damage being comparatively slight as the result of the timely action.

MESSRS. ALEXANDER HALL & COMPANY, LIMITED, Aberdeen, launched the steel-screw sea-going tug which they have built to the order of Messrs. James Dredging, Towage & Transport Company, Limited, London. The vessel has a length of 100 ft. and 29 ft. breadth. The machinery supplied by the builders consists of triple-expansion engines taking steam at 190 lbs. per sq. in. The forward end of the vessel is strengthened by frames spaced closer, and double-shell plating to permit of operation in icebound waters.

THE COLTNESS IRON COMPANY, LIMITED, has decided to cancel the uncalled liability of 5s. a share on the ordinary shares. Last year the ordinary shares of £1, which were fully paid, were reduced by returning 5s. a share to holders, making the nominal value 15s. for each share paid. The directors are now advised that the best policy is to cancel the liability. They are also considering the advisability of creating 262,500 new shares at 15s. each to restore the authorised capital of £1,287,500. An official statement will be made on August 10.

THE WHOLE of the pumps and pumping plant in the Mersey Tunnel has been supplied by Messrs. Drysdale & Company, Limited, Bon Accord Works, Yoker. In addition to the permanent plant, Messrs. Drysdale supplied special submersible pumps during the construction of the tunnel. The tunnel drainage system, for which Messrs. Drysdale were the main contractors, consists of 15 pumps with piping, valves, motors, starters and automatic switchgear, level indicators, alarms, water-measuring apparatus, etc. All the pumps are driven by vertical-spindle motors of English Electric Company's manufacture. All pumps are entirely automatically controlled by the Brookhirst-Drysdale patent "Pneutrol" control device.

THE INTERNATIONAL NICKEL COMPANY has now increased its interest in the Ontario Refining Company, Limited, to 90 per cent. Ventures, Limited, and the Consolidated Mining & Smelting Company of Canada, Limited, have disposed of their shares in the company, and the American Metal Company has sold a portion of its holding. The five-year contract arrangement, running until 1935, whereby the American Metal Company purchased copper from the International Nickel Company, is stated to continue in force. The plant operated at Sudbury by the Ontario Refining Company, Limited, is the largest electrolytic copper refinery in the British Empire, having a rated capacity of 20,000,000 lbs. of copper per month.

MESSRS. GOSSELL & SON, LIMITED, of 110, Cannon Street, London, E.C.4, have been re-appointed the agents of Messrs. "Dortmund-Hoerder Huettenverein Aktiengesellschaft," of Dortmund, for the sale in the British Isles of steel forgings. This connection with the Dortmund works dates back for 55 years. For the last few years, when Dortmund Hoerder formed part of the "Vereinigte Stahlwerke Akt. Ges." (United Steel Works), its products were sold through the selling department at Bochum, but recently, owing to the dissolution of this syndicate, Messrs. Gossell have resumed this agency. The "Dortmund-Hoerder" Company owns some of the largest steel-forging hammers on the Continent, and their shops contain the largest number of turning and boring lathes of any works in Europe.

THE UNITED PATTERNMAKERS' ASSOCIATION report that 1,152 members are unemployed, compared with 2,043 in September last year. Mr. Alan H. Findlay, general secretary, states that there has been a steady improvement in employment, despite which the union is carrying a very heavy burden of unemployment. When allowance is made for the number of members who have left the trade, those on sick or superannuation benefit and apprentices, there are something like 14½ per cent. of members unemployed. The nominations for President of the Association are as follow:—Mr. W. B. Beard, Stockport; Mr. J. Briggs, Erith; Mr. George Buchanan, Glasgow; Mr. A. E. Short, Newcastle; and Mr. A. E. Wardale, London; and for general secretary: Mr. A. H. Findlay, Willesden; Mr. J. S. Brown, Wallsend; Mr. W. J. McLardy, Willesden; and Mr. William Allan, Falkirk.

Company Meeting

Head, Wrightson & Company, Limited

The annual meeting of Messrs. Head, Wrightson & Company, Limited, was held at the Teesdale Ironworks, Thornaby, recently. SIR GUY WRIGHTSON, Bt., who presided, said that the falling away of the export market had affected all firms in the iron and steel and allied heavy industries, but during the last six or eight months the volume of work in the market had increased, and they had secured their full share of the orders which had been placed. From the balance sheet it would be noticed that there was a large increase in the work in progress, and orders booked since the date of the balance sheet indicated that the market was being maintained. If the export market revived in proportion to the home market they would get back into normal conditions.

Contracts Open

London, S.W., July 27.—Tyres for wagons, for the Bombay, Baroda & Central Indian Railway Company, 91, Petty France, Westminster, S.W.1.

Towyn, Merioneth, August 4.—Supply and laying of about 250 yds. of 4-in. spun-iron pipes and other works, for the Urban District Council. The Council Offices, Towyn.

London, E.C., August 2.—Dogspikes, for the Assam-Bengal Railway Company, Limited, Bishopsgate House, 80, Bishopsgate, E.C.2. (Fee £1 1s., not returnable.)

London, E.C., July 31.—400 pairs of wheels and axles for wagons, for the Rohilkund and Kumaon Railway Company, Limited. Mr. W. R. Izat, secretary, 237, Gresham House, Old Broad Street, London, E.C.2. (Fee £1, returnable.)

Levens, August 8.—Provision and laying of 4-in. and 6-in. cast-iron concrete-lined water mains and valves, etc., in connection therewith, and for the construction of a concrete balancing tank at Levens, capacity 40,000 gallons, for the South Westmorland Rural District Council. Mr. H. B. Ward, consulting engineer, 26, North John Street, Liverpool, 2, or Mr. E. Moser, clerk, 15, Lowther Street, Kendal. (Fee £3 3s., returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Henry Stones, Limited, Harland Works, John Street, Sheffield.—Capital £2,000. Manufacturers of iron, steel and alloys. Directors: F. Senior and S. G. Clark.

Brearley Ingot Company, Limited.—Capital £2,000 in £1 shares. Steel, file, saw and edge-tool manufacturers. Directors: H. Brearley, A. B. Winder, A. J. Grant and H. A. Reincke. Subscriber: A. W. Brearley, 142, Totley Brook Road, Sheffield.

Personal

MR F. E. REBBECK, chairman and managing director of Messrs. Harland & Wolff, Limited, Belfast, has been appointed a director of the Northern Counties Committee (Northern Ireland) of the London Midland & Scottish Railway, in succession to the late Mr. Frank Tatlow.

MR. W. H. BASSETT, metallurgical manager, The American Brass Company, Waterbury, Conn., has succeeded Professor T. R. Lawson as President of the American Society for Testing Materials. Mr. H. S. Vassar, laboratory engineer, Public Service Electric & Gas Company, Irvine, New Jersey, has been elected a vice-president.

MR. R. MCINTOSH, assistant foreman of the machinery section of Woolwich Arsenal Engineering Department, who was last week presented with a bureau and Westminster chiming clock by his colleagues on his completion of 36 years' service and retirement, served his apprenticeship with Messrs. John Scott & Company, Whitebank Foundry, Kirkcaldy. Mr. F. Turner, assistant mechanical engineer, made the presentation.

MR. AND MRS. WILLIAM TANNOCK, 24, Montgomerie Street, Ardrossan, celebrated their diamond wedding last week. They received, among numerous messages of congratulation, one from the King and Queen from Buckingham Palace. Mr. Tannock was formerly foreman in Young's Engineering Works, Ardrossan, where he remained until the firm passed out of business. Thereafter he acted as foreman at Ardeer Foundry until 12 years ago, when he retired.

Will

SIMPSON, MATTHEW LANG, formerly chief engineer and general works manager, Steel Company of Scotland, Limited £19,209

Obituary

MR. THOMAS G. CONNELL, of Messrs. Connell, Campbell & Company, iron merchants, Glasgow, died recently.

THE DEATH OCCURRED at his home in Glasgow, on July 15, of Mr. James Dobbie, foreman moulder of Messrs. Walter Macfarlane & Company's Saracen Foundry, Possilpark, Glasgow. Mr. Dobbie was in his 73rd year.

MR. CHARLES HERBERT WILSON, of Jesmond, Newcastle, a former director of Messrs. John Spencer & Company, Newburn Steelworks, and during latter years northern area representative of Messrs. Colvilles, Limited, Glasgow, has died at the age of 62.

MR. FRED BLAND, director of the track-work department of Messrs. Edgar Allen & Company, Limited, Sheffield, died recently, at the age of 74. He was an authority on the rolling of tramlines and the casting of manganese-steel points and crossings.

MAJOR WILLIAM FLEMING, one of the oldest members of the Middlesbrough Exchange, and a man who for over 50 years had been identified with the Cleveland iron trade, died at his residence at Linthorpe recently. A native of Sunderland, he joined the firm of Connal & Company, Limited, at the age of 21 and had 54 years' continuous service with the firm up to the time of his death.

THE DEATH OCCURRED, last week, of Mr. William Russell Steele, son of the late Mr. Robert Steele, of Greenock, who was head of the shipbuilding firm in existence over 150 years, and built one of the first Cunarders. Mr. Steele was 73 years of age, and retired twenty years ago. He spent most of his business career in Calcutta as a partner in Burn & Company, engineers and shipbuilders, to which he went at an early age and ultimately became chairman.

Coercivity of Steels

Discussing recent developments in the manufacture and properties of special steels at an Essen meeting recently, DR. FRY, of Messrs. Fr. Krupp, pointed out that since 1915 the attainable electrical coercivity of magnetic steels had been increased over fourteen-fold. In that year tungsten steels were produced with a coercivity of 70 Oersted, and in 1920 a value of 250 Oersted was reached in cobalt steels. Further research led to steels containing 25 per cent. nickel and 12 per cent. aluminium, with a coercivity up to 800 Oersted, while recently platinum alloys have been produced with coercivities of well above 1,000 Oersted.

WM. CUMMING & CO. LTD.

The Leading Manufacturers!
The Oldest Established!!
The Most Reliable!!!

Ironfounders' Facings Manufacturers and General Foundry Furnishers,

Kelvinvale Mills, Maryhill, GLASGOW

Branches at Falkirk, Chesterfield, Deepfields and Middlesbrough

SUPERFINE COAL DUST

SUPERLATIVELY REGULAR IN GRIST.
SUPERIOR IN QUALITY.
SEVEN GRISTS STANDARDISED.
ONE QUALITY OF COAL THROUGHOUT.

INGOT MOULD BLACKING

THE BEST ON THE MARKET.
MANUFACTURED BY THE NEW PROCESS.

BRITISH PLUMBAGOS

AT LOW PRICES.
IMPORTED DIRECT.
NO CONTINENTAL ADULTERATION.

CUMMING FURNACE

USERS OF THE NEW "CUMMING" FURNACE ARE INCREASING WEEK BY WEEK.

CORECOMPOUNDS, PARTINGS, CUMMINGSTONE, REQUISITES, BLACKINGS for every PURPOSE

ALL OUR OWN MAKE

Raw Material Markets

Discounting purely seasonal movements, it can be said that pig-iron production is very well maintained. Last month the output was 515,000 tons, which compared with less than 346,000 tons in June of last year. This is an indication of the measure of improvement which has been achieved over the last twelve months. Operations at the consuming end continue to be on a good scale. The light-castings industry is well employed, while makers of specialities and the general engineering founders account for a good tonnage of pig-iron. There is now more inquiry with regard to forward contracts, and the furnace-owners expect more activity in this direction, as there is still a lag in the fixing-up of business compared with normal procedure. The steel trade is steady, fair progress being reported in the heavy sections. Following reports that consideration of the applications which were made for higher import duties has been shelved for the time being, more activity has been seen in certain descriptions of Continental steel.

Pig-Iron

MIDDLESBROUGH.—Quiet conditions continue to rule in the Cleveland iron trade, but the causes are purely seasonal ones, and the furnace owners do not express any anxiety with regard to the position. The stocks which are accumulating during the present holiday period are expected to be absorbed as soon as trade gets into its stride again. Before the present slackness set in output was no more than equal to demand, and, in fact, iron was being brought into the area from outside furnaces. As production has not been substantially increased, it is unlikely therefore that the ironmasters will find themselves with an embarrassing surplus at any time during the current year. At the moment foundries and engineering works on the North East Coast are taking reduced quantities, while holidays have also brought down the tonnage despatched to Scotland. To the latter destination, however, deliveries are expected to pick up again very quickly, as the foundries over the border, particularly those making light castings, are still well employed. There is only a small export trade in Cleveland iron, and what business is available has to be taken at low prices in order to meet foreign competition. The steelworks on the North East Coast continue to absorb a large proportion of the output. Prices are unchanged at the fixed official levels, which for delivery in the Middlesbrough area are:—Cleveland No. 3 G.M.B., 67s. 6d.; No. 1 foundry, 70s.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. 6d. per ton. For other areas the fixed zone prices apply.

The East Coast hematite makers continue to maintain a good volume of deliveries to steelmakers in South Wales, the Midlands and Sheffield, and are probably less affected by the seasonal quietness than the makers of foundry numbers. There is no change in prices, the fixed quotations for No. 1 hematite being:—Delivered Middlesbrough, 68s.; North-East Coast, 70s.; Yorkshire, 74s. to 77s.; Birmingham, 79s. In all cases mixed numbers are 6d. per ton less than No. 1 grade. Quotations for export business are not controlled.

LANCASHIRE.—Holidays in various parts of Lancashire continue to affect deliveries of pig-iron, but, this factor apart, a steady trade is maintained. Consumers show more readiness to cover their future requirements, but the volume of forward business booked is still rather below the normal level. The light-castings makers are well engaged, and there is more activity among machinery makers and in electrical engineering. Staffordshire, Derbyshire and North-East Coast brands of No. 3 foundry iron are quoted for delivery to works in Lancashire at the unchanged rate of 74s. per ton basis, Northants No. 3 at 72s. 6d., West Coast hematite at about 80s. 6d., East Coast hematite at 76s. for No. 1 and 75s. for No. 3, and Scottish iron at around 82s. 6d.

MIDLANDS.—More consumers have renewed contracts, but the general procedure has been to cover for lesser quantities. Many contracts lapsed at the end of June, and renewals are now more numerous. At the same time, some consumers are still hanging back, and buying meanwhile in quantities sufficient to meet known requirements. This reluctance to book forward is not easy to explain. Raw-material prices are higher than they were, and promise to remain firm, so that there does not appear to be much prospect of prices moving in favour of buyers; the reverse would indeed seem to be much more probable. Meanwhile, the foundries making light castings continue to be well engaged and other consumers are taking fair tonnages. There have been no alterations in prices, and plentiful supplies are available. The minimum controlled prices for Midland iron delivered Birmingham and Black Country stations are 67s. 6d. per ton for Northants No. 3, and 71s. for Derbyshire, Lincolnshire and Staffordshire No. 3, subject to a sliding-scale rebate to large consumers. A fair amount of business has been done in hematite, and some contracts have been renewed. The controlled prices of 84s. 6d. for West Coast hematite and 78s. for East Coast hematite No. 3 in each case, continue to be quoted. Welsh hematite is uncontrolled and the makers are prepared to accept rather less than the East Coast price. Iron for special engineering work is on offer from various sources. Scottish No. 3 is quoted at about 85s. to 87s. 6d. per ton, and other low-phosphorus irons are available at rates between 81s. and 87s. 6d., with £5 10s. to £6 15s. quoted for special refined iron.

SCOTLAND.—The foundries in the Falkirk area, making light castings, are well engaged, and are taking good quantities of Middlesbrough iron. The holidays have affected trade in the Glasgow area, but with these out of the way trade should improve again. It is unlikely, however, that there will be much activity seen before the end of the month. For Scottish No. 3 iron, the official figure of 70s. per ton f.o.t. furnaces is still in force, with 2s. 6d. extra for No. 1. For No. 3 Cleveland iron the official quotations are 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow.

Coke

A strong tone continues in the coke market, both furnace and foundry grades being upheld in price. The makers are sold well ahead in the home market, and have been offered business running into next year. Few of them, however, will accept contracts for delivery after December. Export demand continues to be on a good scale. For delivery to Midland points, best Durham foundry coke is quoted at between 36s. and 40s. per ton, with other grades down to 34s. and 35s. per ton, while Welsh coke is at between 37s. 6d. and 45s.

Steel

In the semi-finished steel department there has been rather more buying of late. Users, however, continue to purchase on a hand-to-mouth scale and do not seem inclined to enter into forward commitments. Comparatively little business has been transacted in Continental semi-finished steel for this market, although cheap quotations are still heard of. Business in finished steel has been steady rather than active; but recently there has been some improvement in the demand from overseas. Holiday conditions continue to rule in the home market and no broadening in the demand is expected until early in the autumn.

Scrap

There is still a quiet tone in the scrap market, though there is sustained activity in some districts. In the Middlesbrough area, outlets for heavy cast-iron and machinery metal are restricted. The works appear to have good stocks, and they are not anxious buyers at the quoted prices of 47s. 6d. and 50s. per ton respectively. In the Lancashire area the movement of scrap iron has been only moderate, and values are not too strong, with good machinery grades ranging from about 50s. to 52s. 6d. per ton, delivered. In South Wales, heavy cast iron is more difficult to dispose of and is easier at 45s. to 47s. 6d. Light cast-iron scrap is also less active and is easier at 40s. to 42s. 6d., while transactions in good cast-iron machinery scrap for foundries are confined to small parcels at 50s. to 52s. 6d. In the Midlands, heavy machinery metal in handy sizes is at 55s., heavy pipe and plate scrap at 50s., and clean light metal at 47s. 6d., all delivered works. There has been little or no business passing in Scotland, owing to the holidays, and quotations are only nominal.

Metals

Copper.—Prices on the standard copper market have remained fairly steady during the past week, but there has been no improvement in the tone of the market, and some observers express doubts that the lowest level has been seen. In this country production is quite well maintained on the whole, but demand on the Continent is poor, the lack of buying on the part of Germany being a depressing feature.

In their weekly report Messrs. Brandeis, Goldschmidt & Company state: "The standard market has been subjected to heavy liquidation at times. The strike in America is thought in some quarters to be only a prelude to other labour troubles, which would result in a consequent falling off in consumption. In actual fact, however, there is every indication that stocks are still declining, if only slowly, and the margin of profit for producers is now so low that most of them will hesitate before increasing their output. The standard market at one time fell to £29 7s. 6d. per ton, three months, which, if calculated in terms of gold, is about the lowest price ever reached. The market is still largely under the influence of sentiment, but the undertone has improved."

Daily quotations:—

Cash.—Thursday, £29 10s. to £29 11s. 3d.; Friday, £29 10s. to £29 11s. 3d.; Monday, £29 8s. 9d. to £29 10s.; Tuesday, £28 16s. 3d. to £28 17s. 6d.; Wednesday, £28 17s. 6d. to £29.

Three Months.—Thursday, £29 16s. 3d. to £29 17s. 6d.; Friday, £29 17s. 6d. to £29 18s. 9d.; Monday, £29 16s. 3d to £29 17s. 6d.; Tuesday, £29 2s. 6d. to £29 3s. 9d.; Wednesday, £29 5s. to £29 6s. 3d.

Tin.—Influential support from quarters generally believed to be associated with the buffer pool has upheld prices on the standard tin market, which without this support would undoubtedly have registered a decline. The market at the moment is dull and uninteresting. Consumption in this country is on a fair scale, but on the Continent and in America is comparatively poor. Immediate prospects are not very favourable.

Market prices:—

Cash.—Thursday, £230 7s. 6d. to £230 10s.; Friday, £230 7s. 6d. to £230 10s.; Monday, £230 7s. 6d. to £230 10s.; Tuesday, £230 5s. to £230 7s. 6d.; Wednesday, £233 7s. 6d. to £233 10s.

Three Months. — Thursday, £230 5s. to £230 7s. 6d.; Friday, £230 5s. to £230 7s. 6d.; Monday, £230 5s. to £230 7s. 6d.; Tuesday, £230 5s. to £230 7s. 6d.; Wednesday, £233 2s. 6d. to £233 5s.

Spelter.—The past week has failed to bring any improvement to this market. The galvanising industry in this country is only poorly employed, but consumption, on the whole, does not show much movement one way or the other. Very quiet conditions are reported in consuming circles on the Continent.

Messrs. Rudolf Wolff & Company, in their weekly review, state:—"Confidence, shaken by the recent events in Germany and by the further weakness of the copper market, has not returned, nor has the situation been improved by reports to the effect that, at the Cartel meeting held at Ostend last week, production quotas were raised from 50 per cent. to 60 per cent.; the Cartel arrangements were, however, it is understood, prolonged until December 31. The lower prices are attracting a little more buying, and the market at the close presents a rather steadier undertone. In the United States of America, conditions show no material change, and the price remains steady."

Day-by-day prices:—

Ordinary. — Thursday, £13 5s.; Friday, £13 8s. 9d.; Monday, £13 6s. 3d.; Tuesday, £13 5s.; Wednesday, £13 6s. 3d.

Lead.—Steady conditions have ruled in this market. Consumption is on a good scale and the price is comparatively low, while statistically the position is sound. The recent steadiness is likely to continue, with an upward movement as soon as any expansion of general industrial activity is seen. Sellers have not been anxious to push sales.

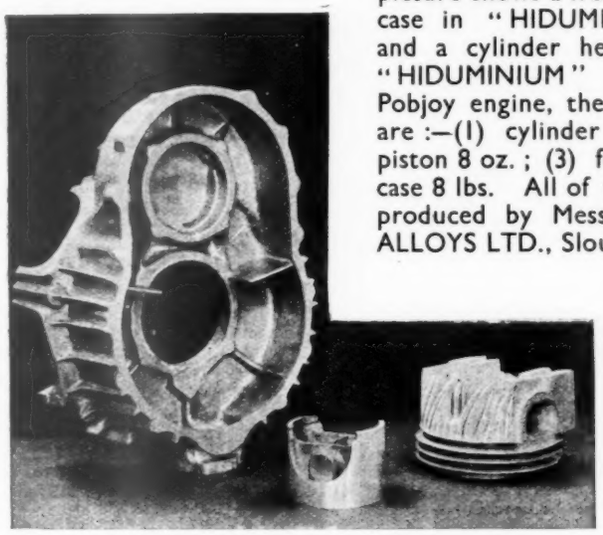
Market fluctuations:—

Soft Foreign (Prompt).—Thursday, £10 15s.; Friday, £10 16s. 3d.; Monday, £10 13s. 9d.; Tuesday, £10 13s. 9d.; Wednesday, £10 15s.

XUM

LIGHT ALLOYS *for* AIRCRAFT

The top picture shows an air-cooled engine cylinder head in "HIDUMINIUM" R.R. 53, the weight of which is 12 lbs. The lower picture shows a front half of a crank-case in "HIDUMINIUM" R.R. 50, and a cylinder head and piston in "HIDUMINIUM" R.R. 53 of the Pobjoy engine, the weights of which are :—(1) cylinder head 2 lbs. ; (2) piston 8 oz. ; (3) front half of crank-case 8 lbs. All of these castings are produced by Messrs. HIGH DUTY ALLOYS LTD., Slough.



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The BRITISH ALUMINIUM CO. *Ltd.*

HEAD OFFICE: ADELAIDE HOUSE, KING WILLIAM ST., LONDON. E.C.4.
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The BRITISH ALUMINIUM COMPANY *Ltd.*

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BARROW IRON

WEST COAST HÆMATITE
REFINED CUPOLA
OPEN HEARTH REFINED

Also **SEMI-PHOSPHORIC**
for Motor Cylinders, Valve Bodies, Steam and Hydraulic Castings, Etc.

LONDON OFFICE :
59, VICTORIA ST., S.W.1.

THE BARROW HÆMATITE STEEL CO., LTD., BARROW-IN-FURNESS, LANCS.

RAW MATERIALS—PRICE LIST

(Wednesday, July 25, 1934)

COPPER

	£	s.	d.
Standard cash	28	17	6
Three months	29	5	0
Electrolytic	32	0	0
Tough	30	15	0
Best selected	31	5	0
Sheets	60	0	0
India	42	0	0
Wire bars	32	5	0
Ingot bars	32	5	0
H.C. wire rods	34	15	0
Off. av. cash, June	32	3	9
Do., 3 mths., June	32	10	5 5/8
Do., Sttlmnt., June	32	3	9 1/2
Do., Electro, June	35	10	7 1/2
Do., B.S., June	35	3	7 1/2
Do., wire bars, June	35	14	4 1/2
Solid drawn tubes			9 1/4d.
Brazed tubes			9 1/4d.
Wire			6 1/4d.

BRASS

Solid drawn tubes	8 3/4d.
Brazed tubes	10 1/2d.
Rods, drawn	8 1/4d.
Rods, extd. or rlld.	4 1/2d.
Sheets to 10 w.g.	7 1/4d.
Wire	7 1/2d.
Rolled metal	6 3/4d.
Yellow metal rods	4 1/2d.
Do. 4 × 4 Squares	5 1/2d.
Do. 4 × 3 Sheets	5 3/4d.

TIN

	£	s.	d.
Standard cash	233	7	6
Three months	233	2	6
English	233	10	0
Bars	235	2	6
Straits	233	10	0
Australian (nom.)			—
Eastern	233	5	0
Banca	234	5	0
Off. av. cash, June	226	19	9 6/7
Do., 3 mths., June	226	3	6 1/2
Do., Sttlmt., June	226	18	9 5/7

SPELTER

	£	s.	d.
Ordinary	13	6	3
Remelted	14	0	0
Hard	11	2	6
Electro 99.9	15	17	6
English	13	17	6
India	13	0	0
Zinc dust	16	10	0
Zinc ashes	3	0	0
Off. aver., June	14	7	1
Aver. spot, June	14	4	9 2/7

LEAD

	£	s.	d.
Soft foreign ppt.	10	15	0
Empire (nom.)	11	3	9
English	12	10	0
Off. average, June	11	3	0 1/4
Average spot, June	11	1	0 2/7

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	5	0
Do., V.M. ex whse.	21	12	6
Rods	27	10	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	40	0	0	to	43	0	0
Chinese, ex-whse.					36	0	0
Crude					24	0	0

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	0	0	to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£13 0 0
75%	£18 7 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	3/3 lb.
Tungsten metal powder—	
98/99%	3/6 lb.
Ferro-chrome—	
2/4% car.	£29 15 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£38 15 0
Max. 0.70% car.	£42 0 0
70%, carbon-free	10d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under 1/2 in. to 1/4 in. 3d. lb.
Do., under 1/4 in. to 1/8 in. 1/- lb.
Flats, 1/2 in. × 1/4 in. to under 1 in. × 1/8 in. 3d. lb.
Do., under 1/4 in. × 1/4 in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	13	0	to	2	15	0
Bundled shrngs.					2	7	6
Mixed iron and steel	2	8	0	to	2	10	0
Heavy cast iron	2	5	0	to	2	7	6
Good machinery	2	10	0	to	2	12	6
Cleveland—							
Heavy steel					2	10	0
Steel turnings					1	17	6
Cast-iron borings					1	7	6
Heavy forge					2	10	0
W.I. piling scrap					2	5	0
Cast-iron scrap	2	7	6	to	2	10	0
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					3	0	0
Steel turnings, f.o.r.					1	13	0
Scotland—							
Heavy steel	2	10	0	to	2	11	3
Ordinary cast iron					2	11	3
Engineers' turnings					2	0	0
Cast-iron borings					2	0	0
Wrought-iron piling					2	10	0
Heavy machinery					2	12	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	25	0	0
Brass	17	10	0
Lead (less usual draft)	9	10	0
Tea lead	7	0	0
Zinc	9	0	0
New aluminium cuttings	69	0	0
Braziery copper	22	0	0
Gunmetal	23	0	0
Hollow pewter	145	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	68/-
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	80/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.	12	0	0				
Gas strip	10	10	0	and up.			
Bolts and nuts, 3/4 in. × 4 in.	14	0	0				
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	0	0	to	8	10	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5 1/2 in.					9	7	6
Rounds under 3 in. to 5/8 in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)					9	7	0
Black sheets, 24g. (4-t. lots)					10	10	0
Galv. cor. shts. (,,)					13	0	0
Galv. flat shts. (,,)					13	10	0
Galv. fencing wire, 8g. plain					14	10	0
Billets, soft					5	10	0
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	0	0	to	5	5	0
Tin bars					5	0	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	11 1/2d.
Rods	10 1/2d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1 1/2 to 1/7 1/2
To 15 in. wide	1/1 1/2 to 1/7 1/2
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2 1/2 to 1/8 1/2
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3 1/2
Ingots rolled to spoon size	10d. to 1/6 1/2
Wire round—	
to 10g.	1/4 1/2 to 1/11 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3 1/2 upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.25
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37 1/2
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.90
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.45
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	20/-
Durham foundry	21/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/-
,,	28×20 ,,		36/-
,,	20×10 ,,		26/-
,,	18 3/4×14 ,,		18/6
C.W.	20×14 ,,		15/3
,,	28×20 ,,		34/-
,,	20×10 ,,		22/4 1/2
,,	18 3/4×14 ,,		15/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	6	0	0	to	7	0	0
Bars-hammered, basis	16	0	0	to	16	10	0
Bars and nail-rods, rolled, basis	15	15	0	to	16	0	0
Blooms	10	0	0	to	12	0	0
Keg steel	30	0	0	to	31	0	0
Faggot steel	18	0	0	to	23	0	0
Bars and rods dead soft, st'l	10	0	0	to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.	
July	19 ..	29	10	0	No change
,,	20 ..	29	10	0	,, ,,
,,	23 ..	29	8	9	dec. 1/3
,,	24 ..	28	16	3	,, 12/6
,,	25 ..	28	17	6	inc. 1/3

Electrolytic Copper

		£	s.	d.	
July	19 ..	32	10	0	No change
,,	20 ..	32	10	0	,, ,,
,,	23 ..	32	10	0	,, ,,
,,	24 ..	32	0	0	dec. 10/-
,,	25 ..	32	0	0	No change

Standard Tin (cash)

		£	s.	d.	
July	19 ..	230	7	6	dec. 2/6
,,	20 ..	230	7	6	No change
,,	23 ..	230	7	6	,, ,,
,,	24 ..	230	5	0	dec. 2/6
,,	25 ..	233	7	6	inc. 62/6

Tin (English ingots)

		£	s.	d.	
July	19 ..	230	12	6	No change
,,	20 ..	230	12	6	,, ,,
,,	23 ..	230	12	6	,, ,,
,,	24 ..	230	7	6	dec. 5/-
,,	25 ..	233	10	0	inc. 62/6

Spelter (ordinary)

		£	s.	d.	
July	19 ..	13	5	0	dec. 2/6
,,	20 ..	13	8	9	inc. 3/9
,,	23 ..	13	6	3	dec. 2/6
,,	24 ..	13	5	0	,, 1/3
,,	25 ..	13	6	3	inc. 1/3

Spelter (Electro, 99.9 per cent.)

		£	s.	d.	
July	19 ..	15	17	6	dec. 2/6
,,	20 ..	16	0	0	inc. 2/6
,,	23 ..	15	17	6	dec. 2/6
,,	24 ..	15	16	3	,, 1/3
,,	25 ..	15	17	6	inc. 1/3

Zinc Sheets (English)

		£	s.	d.	
July	19 ..	23	5	0	No change
,,	20 ..	23	5	0	,, ,,
,,	23 ..	23	5	0	,, ,,
,,	24 ..	23	5	0	,, ,,
,,	25 ..	23	5	0	,, ,,

Lead (English)

		£	s.	d.	
July	19 ..	12	10	0	No change
,,	20 ..	12	10	0	,, ,,
,,	23 ..	12	10	0	,, ,,
,,	24 ..	12	10	0	,, ,,
,,	25 ..	12	10	0	,, ,,

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	•	•	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 0	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	87 0	87 0	87 3	87 2½	87 6	89 6	89 6	89 10½	86 11
1930	91 6	91 6	91 6	90 0	89 7½	88 0	87 7½	86 6	86 6	86 6	86 6	86 6	88 6½
1931	86 6	84 6	84 6	84 6	84 6	82 6	82 6	81 6	81 6	83 6	83 6	83 6	83 7
1932	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1933	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1934	83 6	83 6	83 6	83 6	83 6	83 6	—	—	—	—	—	—	—

• No prices available.

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12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories £290 Nett.

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